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Prescott National Forest

Hydrology and Soils Specialist Report

Forest Plan Revision
DEIS

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Table of Contents

Introduction.....	1
Need for Change.....	3
Affected Environment	3
River Basins	5
Surface Waters	9
Watershed Conditions	11
Riparian and Wetland Resources.....	14
Water Quality	17
Groundwater.....	24
Water Use.....	25
Soils.....	26
Summary of Alternatives	30
Methodology and Analysis Process	32
Environmental Consequences.....	32
Vegetation Management.....	33
Roads and Trails.....	36
Mining	36
Watershed Integrity	37
Recreation	38
Grazing.....	40
Climate Change	41
Cumulative Environmental Consequences.....	43
References.....	46
Appendix A - 5 th level HUC Watershed Map.....	49
Appendix B – Watershed Condition Framework Assessment.....	50

List of Tables

Table 1. Hydrologic Unit Code terms and examples	4
Table 2. Hierarchy of hydrologic units intersecting with the Prescott NF.....	4
Table 3. Bill Williams watersheds (5th level HUC) extent and perennial stream miles.....	5
Table 4. Verde watersheds (5th level HUC) extent and perennial stream miles	7
Table 5. Agua Fria – Lower Gila watersheds (5th level HUC) extent and perennial stream miles	8
Table 6. Overall Watershed Condition Assessment.....	12
Table 7. Sub-watershed conditions, by indicator	12
Table 8. Springs and seeps, by watershed (5th level HUC).....	16
Table 9. ADEQ Water Quality Attainment Categories.....	18
Table 10. Water Quality Summary	19
Table 11. Soil types for PNVN.....	26
Table 12. Soil Condition	28
Table 13. Comparison of Alternatives: Watershed Integrity	37
Table 14. Comparison of Alternatives: Recreation.....	39
Table 15. Prescott NF 4 th level HUC	43
Table 16. HUC-12 conditions (Appendix B).....	50
Table 17. Select condition indicators aggregated at the HUC-10 scale (Appendix B).....	54

Introduction

The purpose of this report is to evaluate the potential environmental consequences to water and soil resources that may result with the adoption of a revised land management plan. It examines the consequences of taking no action to revise the existing plan and of three alternative actions: the proposed revision of the Forest Plan, an alternative that emphasizes vegetation and wildlife habitat restoration, and an alternative that emphasizes dispersed recreation opportunities.

The Prescott National Forest Analysis of the Management Situation (Forest Service 2009a) report identified the need to maintain/improve watershed integrity. The Prescott National Forest determined that a combined water and soil resource report would best address the need for change.

This report describes:

- The laws that are relevant to water resources management on the Prescott National Forest
- The hydrologic and soils environment affected by the alternatives
- The needs for change identified in revising the existing plan
- The sections of each proposed alternative that are relevant to water and soils
- The environmental consequences of the alternatives
- The relationship between the short-term and long-term consequences of the alternatives
- The cumulative consequences to the environment of the alternatives

Relevant Laws, Regulations, and Policy that Apply

The Federal Water Pollution Control Act of 1972 (Public Law 92-500) as amended in 1977 (Public Law 95-217) and 1987 (Public Law 100-4), also known as the **Federal Clean Water Act** (CWA):

- CWA Sections 208 and 319: recognize the need for control strategies for non-point source pollution. Non-point is the primary pollution source for grazing activities.
- CWA Section 303(d): requires water bodies with water quality determined to be either impaired (not fully meeting water quality standards) or threatened (likely to violate standards in the near future), to be compiled by the Arizona Department of Environmental Quality in a separate list which must be submitted to EPA biannually. These waters are targeted and scheduled for development of water quality improvement strategies on a priority basis.
- CWA Section 305(b): require that states assess the condition of their waters and produce a biannual report summarizing the findings.

Wild and Scenic Rivers Act (1968) – The outstandingly remarkable values of rivers eligible or suitable to be included in the system must be carefully managed. Any management activities that could negatively impact these values should not be conducted.

Pertinent Executive Orders:

- Executive Order 11988 – Floodplain Management: Floodplains come under special considerations under Executive Order 11988. The purpose of the Order is "...to avoid to the extent possible the long and short term impacts associated with the occupancy and modification of floodplains..." Section 1 further states: "...to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains..."
- Executive Order 11990 - The Protection of Wetlands: Wetlands are protected under this order and directs federal agencies to "...minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands..." Section 5 also states: "In carrying out the activities described in Section 1 of this Order, each agency consider factors relevant to a proposal's effect on the survival and quality of the wetlands. Among these factors are: (a) public health, safety, and welfare, including water supply, quality, recharge and discharge; pollution; flood and storm hazards; and sediment and erosion..."

Forest Service Manual Requirements:

- Forest Service Manual (FSM) guidelines describe the objectives and policies relevant to protection (and, where needed, improvement) of water quality on National Forest System lands so that designated beneficial uses are protected (FSM 2532.02 and 2532.03).
- FSM 2554: The National Forest Management Act requires that lands be managed to ensure the maintenance and long-term soil productivity, soil hydrologic function, and ecosystem health. Soil quality is maintained when erosion, compaction, displacement, rutting, burning, and loss of organic matter are maintained within defined soil quality standards.

Best Management Practices: The State has implemented their non-point source management plans through State approved BMPs. BMPs (FSH 2509.22) are methods, measures, or practices to prevent or reduce water pollution, including, but not limited to, structural and nonstructural controls and operation and maintenance procedures. These practices are usually applied as a system of practices rather than a single practice and are selected on the basis of site-specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. Section 310 of the Clean Water Act directed States to identify BMPs for categories of nonpoint source problems, and develop programs to implement the BMPs. Through a Memorandum of Understanding (MOU), ADEQ has designated the Forest Service to be responsible to identify, implement and monitor the effectiveness of BMPs to assure that State Water Quality Standards (SWQS) are being met.

Arizona law also has specific requirements regarding grazing. ADEQ has adopted a "surface water quality general grazing permit consisting of voluntary best management practices for grazing activities." Although ADEQ must require the application of economically feasible voluntary BMPs that are "the most practical and effective means" of reducing or preventing discharge of pollutants by grazing activities, ADEQ "shall not require application of more

stringent practices if such a requirement would result in cessation or significant reduction of grazing activity.” The law requires the development and issuance of a permit, but because the BMPs are voluntary, there may be little enforceable action beyond simply requiring the permit.

CWA § 401- State Certification for Grazing, Wetland Dredging, and Mining: Section 401(a) requires any applicant for a federal license or permit which may result in any discharge into waters of the United States to provide to the licensing agency a certification from the state in which the discharge originates that the discharge will comply with applicable provisions of the CWA including SWQS and any other appropriate state law. This provision applies to federal licenses and permits, and has been used to control pollution from hydroelectric projects, mining projects, and wetland dredging. A more recent ruling concludes that grazing does not constitute a point source of pollution and does not require State 401 certification. However, for wetland dredging and mining activities, State certification is required and as such will mitigate adverse sources of pollution in wetland environments and will provide favorable conditions for ecosystem diversity.

Need for Change

Retain or improve watershed integrity to provide desired water quality, quantity, and timing of delivery.

Addressing this need would provide improved water quality for human health and safety, would move toward maintaining water quantity for both municipal watersheds and maintenance of aquatic and riparian species habitat, and would provide timing of delivery that is commensurate with healthy soil and biological function and natural geomorphology.

Issues to be addressed:

- Desired conditions and activities to improve vegetation structure and composition, disturbance regimes, and recreation activities are needed to avoid impacts on watershed function.
- Desired conditions and management methods that help retain or improve the function of riparian areas, seeps, and springs need to be identified.
- Desired conditions need to be maintained or restored to better provide needed water quality, quantity, and timing of delivery to municipal watersheds and aquatic and riparian species habitat.
- Ecosystem resilience, in both uplands and near water bodies, needs to be promoted to respond to climate change.

Affected Environment

The Prescott National Forest (Prescott NF) lies mainly within the Central Highlands of Arizona spanning 1,250,000 acres. The Prescott NF is one of six National Forests within the state of Arizona. The Prescott NF forms the headwaters of the Verde, Hassayampa, and Agua Fria Rivers. A small portion of the forest also lies within the eastern headwaters of the Bill Williams River

Basin. The United States Geological Survey developed a hierarchical system for defining ordered watersheds. A set of commonly used terms describe relative geographic areas. These areas are referred to as a Hydrologic Unit Code (HUC) and used with a series 2 digit numeric descriptor refer to the order within the hierarchy. A Watershed is synonymous with a HUC-10 or 5th level HUC (Table 1).

Table 1. Hydrologic Unit Code terms and examples

Hierarchy Term	Level	HUC	Example
Region	1 st level hydrologic unit	15	Colorado
Sub-region	2 nd level hydrologic unit	1506	Salt River
River Basin	3 rd level hydrologic unit	150602	Verde
Sub-basin	4 th level hydrologic unit	15060202	Upper Verde
Watershed	5 th level hydrologic unit	1506020207	Cherry Creek
Sub-watershed	6 th level hydrologic unit	150602020701	Bitter Creek

The Prescott NF is comprised of two mostly contiguous land masses that are roughly the same size and shape that are separated by the Big Chino Valley. The varied land ownership in the vicinity of Prescott NF influences the hydrologic processes both in and around the Prescott NF. Major land ownership between the two tracts of the Prescott NF includes the Bureau of Land Management (BLM), Arizona State Trust, and private. The private land includes several communities including Prescott, Prescott Valley, Chino Valley. There are also large tracts of private land with agriculture being the primary land use. State trust land is often leased agricultural use and may be sold to developers hence management of this land is varied and subject to significant change.

The Prescott NF land base falls within portions of eight sub-basins; each sub-basin is comprised of a number of watersheds, and watersheds are further divided into sub-watersheds. The Prescott NF overlaps with portions of 22 watersheds and 127 sub-watersheds. The hierarchical relationship of these hydrologic units is displayed below in Table 2.

Table 2. Hierarchy of hydrologic units intersecting with the Prescott NF

River Basin 3 rd level	Sub-Basin 4 th level	Watersheds 5 th level	Sub-watersheds 6 th level
Bill Williams River	Big Sandy	1	3
	Burro Creek	2	3
	Santa Maria	2	16
Verde River	Big Chino Wash	4	25
	Upper Verde	5	34
	Lower Verde	1	7

River Basin 3 rd level	Sub-Basin 4 th level	Watersheds 5 th level	Sub-watersheds 6 th level
Lower Gila / Agua Fria Rivers	Aqua Fria	5	30
	Hassayampa	2	9
	Totals	22	127

River Basins

The Prescott NF administers land within three named river basins: The Bill Williams River, The Verde River, and The Lower Gila/Aqua Fria Rivers. The Prescott NF is bordered by three National Forests, the Kaibab to the northeast, the Coconino to the east, and the Tonto to the southeast. The Kaibab and the Coconino share portions of the Verde River watershed, and the Tonto shares portions of the Verde and Agua Fria watersheds.

Bill Williams River Basin

The Prescott NF in the Bill Williams River Basin comprises 14% of the areal extent of the entire forest. The Prescott NF land in the five watersheds (HUC -10) within the Bill Williams River Basin lie in the uppermost reaches of the watersheds defined by the Juniper Mountains. Annual average precipitation of the watersheds within forest boundaries ranges 17 – 27 inches with the average for the area approximately 21. The precipitation on Prescott NF lands in this watershed is disproportionately high in comparison to the entire watershed. The streams on the Prescott NF flow west into the Mojave Desert. Only two short reaches of two streams, Copper Basin Wash, and Weed Canyon, within forest boundaries are identified as perennial. Perennial flow in this watershed is frequently interrupted even on the larger main stem rivers. Open range grazing is the primary land use. One large mining complex exists within the river basin, and historic mine sites are scattered throughout the watershed. No large population centers exist within the basin. The Prescott NF manages very little land within the Bill Williams River Basin, and therefore has little hydrologic influence in context of the river basin scale.

Table 3. Bill Williams watersheds (5th level HUC) extent and perennial stream miles

Basin	Sub-basin	Watershed	WS (sq mi)	PNF (sq mi)	PNF as % of WS	WS Stream Miles	PNF Stream Miles	PNF as % of WS
Bill Williams River	Big Sandy River	Muddy Creek 1503020102	187	18	9.8 %	0.0	0.0	0.0 %
	Burro Creek	Upper Burro Creek 1503020202	171	13	7.7 %	19.2	0.0	0.0 %
		Boulder Creek 1503020203	150	16	10.8 %	0.0	0.0	0.0 %

Basin	Sub-basin	Watershed	WS (sq mi)	PNF (sq mi)	PNF as % of WS	WS Stream Miles	PNF Stream Miles	PNF as % of WS
	Santa Maria River	Kirkland Creek 1503020301	405	74	18.3 %	16.4	0.9	5.4%
		Sycamore Creek 1503020302	237	152	64.3 %	2.9	0.2	5.5%

Verde River Basin

The Verde River is the only major perennial stream with continuous flow from headwaters to the confluence with the Salt River, and eventually the Gila River. The headwaters begin on the Prescott NF in the Granite Creek drainage. Fifty-two miles of the 195 mile long Verde River, flow through the Prescott. The aquifers in Big Chino Valley are the primary source of Big Chino Springs, supplying at least 80% of the upper Verde River's base flow (Wirt et al. 2000). There are 102 major springs with a measured discharge of 10 gallons per minute or greater at any time, the largest number reported in any groundwater basin in Arizona (ADEQ, 2009). There are 83 minor springs identified and as many as 571 springs mapped by the U.S. Geological Survey. Forty-nine percent of the areal extent of the Prescott NF lies within the Verde River Basin. Portions of ten watersheds (HUC-10) are delineated within the Prescott NF. In the Verde River Basin the Prescott NF constitutes 16%, 22%, and 3%, respectively, of the Big Chino Wash, Upper Verde and Lower Verde 4th level (sub-basins) or a total of about 15% of the Verde River Basin. Three other National Forests – Kaibab, Coconino, and Tonto – make up a much larger portion of this river basin so that about 56% of the Verde River Basin is National Forest (University of Arizona NEMO).

Average annual precipitation on Prescott NF lands within these watersheds ranges from 13 – 31 inches with higher precipitation occurring at high elevations. The rugged terrain influences the spatial precipitation patterns and some of the most arid regions of the Prescott NF lie within the Verde watersheds. Vegetation types include Sonoran Desert, semi-desert plains, Great Basin grasslands, interior chaparral, and conifer forests. Riparian vegetation includes mesquite, and mixed broadleaf.

The Verde River flows through alternating bedrock canyons and broader alluvial valleys influencing channel morphology. Multiple reaches of the Verde River have been either designated or found eligible for Wild and Scenic River status because of outstanding values. This river system supports tremendous ecological and cultural diversity. The Verde River remains free of large dams and large scale regulation of flow; however, flows along the river have been substantially altered by diversions and groundwater pumping (Nature Conservancy, 2008). The Verde River is dynamic, and experiences periods of natural instability from floods and droughts. Human disturbances such as mining, grazing, and urbanization also play a role in the Verde River. Impacts to water quality are described below.

There are approximately 52 miles of the Verde River within and/or forming the boundary of the Prescott NF. Of this the upper 11.6 miles are assessed as Category 1, the next 6.7 miles are

omitted in the assessment, and the remaining 34 miles are assessed as Category 4, with a Total Maximum Daily Load (TMDL), due to exceedances of the former turbidity standard during storm events. ADEQ has recommended that the turbidity standard be replaced with suspended sediment and that proposed standard has been exceeded only during runoff from major storm events. The major identified non-point source pollutant that may be carried downstream to lower reaches of the Verde River and Horseshoe Reservoir is sediment but the contribution coming from the Forest is probably small since Forest reaches are no longer listed for turbidity (Forest Service 2009c).

The Verde River mainstem is trending toward Reference condition due to improved riparian conditions and floodplain/ channel development following the removal of livestock (RMRS photo monitoring report; ADEQ 2001; Prescott NF 2001 from Forest Service 2008).

Table 4. Verde watersheds (5th level HUC) extent and perennial stream miles

Basin	Sub-basin	Watershed	WS (sq mi)	PNF (sq mi)	PNF as % of WS	WS Stream Miles	PNF Stream Miles	PNF as % of WS
Verde	Big Chino Wash	Lower Partridge Creek* 1506020105	204	1	0.4 %	0.0	0.0	0.0 %
		Middle Big Chino Wash 1506020106	300	38	12.7 %	0.0	0.0	0.0 %
		Williamson Valley Wash 1506020107	321	169	52.6 %	11.5	0.08	0.7%
		Lower Big Chino 1506020108	364	136	37.5 %	0.4	0.4	100%
	Upper Verde River	Granite Creek 1506020201	359	70	19.5 %	13.6	4.1	30.1%
		Hell Canyon* 1506020202	237	104	44.0 %	4.4	0.5	12.3%
		Sycamore Creek* 1506020203	477	35	7.4 %	11.4	0.84	7.4%

* Major portions of these watersheds are within other National Forests adjacent to the Prescott NF.

Basin	Sub-basin	Watershed	WS (sq mi)	PNF (sq mi)	PNF as % of WS	WS Stream Miles	PNF Stream Miles	PNF as % of WS
		Grindstone Wash 1506020204	309	227	73.5 %	33.6	27.9	83.1%
		Cherry Creek* 1506020207	226	117	51.6 %	32.7	3.4	10.4%
	Lower Verde River	Fossil Creek* 1506020303	299	65	21.7 %	48.8	18.4	36.0%

Lower Gila - Agua Fria River Basin

The Agua Fria River and the Hassayampa River comprise the two hydrologic units located on the Prescott NF within the Lower Gila – Agua Fria River Basin. Both rivers run from north to south through the center of their watersheds. The watersheds are characterized by mid elevation mountains and valleys. Vegetation types include Sonoran desert, semi-desert grassland, interior chaparral, montane conifer forests. Riparian vegetation includes cottonwood, willow, mesquite, and mixed broadleaf. Land ownership in the Agua Fria is predominantly federal (> 75%). The Prescott and Tonto National Forests administer 47% of the land. In the Hassayampa, 45% of the lands are federally managed, 25% by the Prescott NF. Thirty-eight percent of the lands are state owned. Average annual precipitation on Prescott NF lands within these watersheds ranges from 17 – 29 inches with higher precipitation occurring at high elevations. Flood alert systems are prevalent in both watersheds. There are four majors springs (>10 gpm) located on the Prescott NF in the Agua Fria drainage. Hundreds of minor springs have been identified in both watersheds. Many of these are used as sources of water for livestock. Water quality on the Prescott NF has exceeded water quality standards in these watersheds for cadmium, lead, radionuclides, arsenic, copper, zinc, and pH. Cadmium, lead, zinc, copper, and pH are attributed to historical mining. TMDL have been completed for these areas. Arsenic and radionuclides are known to occur naturally in some of the local geologic formations, however it is possible that mining activities have contributed to these exceedances. Mining has played a large role in these watersheds. Significant portions of the larger streams have been dredged impacting aquatic habitat, stream stability, water chemistry, and sub-surface flow. Grazing is also a major land use in this area. Population and groundwater use in these watersheds has more than doubled in the last quarter century.

Table 5. Agua Fria – Lower Gila watersheds (5th level HUC) extent and perennial stream miles

Basin	Sub-basin	Watershed	WS (sq mi)	PNF (sq mi)	PNF as % of WS	WS Stream Miles	PNF Stream Miles	PNF as % of WS
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Basin	Sub-basin	Watershed	WS (sq mi)	PNF (sq mi)	PNF as % of WS	WS Stream Miles	PNF Stream Miles	PNF as % of WS
Lower Gila - Agua Fria	Agua Fria River	Ash Creek / Sycamore Creek 1507010201	261	232	89.1 %	22.5	7.7	34.2 %
		Big Bug Creek 1507010202	324	90	27.6 %	7.6	0.9	11.6 %
		Black Canyon Creek 1507010203	244	158	64.9 %	0.4	0.4	100.0 %
		Bishop Creek [*] 1507010204	236	26	11.0 %	11.7	0.4	0.0 %
		Agua Fria River-Lake Pleasant 1507010205	372	25	6.6 %	1.8	0.4	21.8 %
	Hassayampa River	Upper Hassayampa River 1507010301	303	192	63.3 %	15.1	13.3	88.3 %
		Middle Hassayampa River 1507010303	349	3	0.8 %	13.0	0.0	0.0 %

Surface Waters

There are approximately 80 miles of perennial streams on the forest. Other than the Verde River, most perennial streams flowing through the Prescott NF experience spatially interrupted surface flow, especially during periods of drought. Climate conditions, temperature and precipitation, are strongly correlated with altitude. Precipitation is generally bimodal, with most precipitation occurring during summer monsoons and winter frontal storms. Because of the relatively higher precipitation in the central highlands, Prescott NF lies within the most important water producing watersheds in Arizona. The climate is cyclic in nature, with consecutive years of low rainfall and extended droughts, as well as years with high precipitation associated with flooding. Local flood peaks generally occur during major precipitation events. Wildland fire related flood events are

^{*} Major portions of this watershed are within other National Forests adjacent to the Prescott NF.

exacerbated by the large amounts of sediments that increase the flood volumes. The rugged topography of the Prescott NF provides a relatively direct delivery system for precipitation and sediment to reach streams.

The combination of high intensity rainfall events, lack of natural groundcover, and steep slopes often generates high magnitude storm events that transform stream channel morphology and associated riparian habitat, which should be recognized when describing aquatic and riparian habitat areas and evaluating potential human impacts on stream channel morphology and aquatic and riparian habitat in central Arizona.

The following describes stream channel characteristics found on the Prescott NF. Dryland river systems are dominated by short, high magnitude storm events. In areas with substantial coarse alluvium, many arid rivers exhibit braided channel morphology. Braided channels are generally characterized by abundant bedload, steep channel gradients, highly erodible banks, and highly variable discharge (Graf 1988 from US Army Corps of Engineers 2001). In dryland river systems, flood events are almost always the forcing factors that convert meandering channels to a braided morphology. In several arid regions, large storm events have been responsible for changing the dominant channel configuration from meandering to braided in watersheds of varying sizes. The Gila River in eastern Arizona in the late 1890s had a narrow (only meters wide in some areas) meandering stream channel, but in 1905 a series of large storm events eliminated the meandering channel and produced a braided channel more than a kilometer wide in some reaches (Graf 1988 from US Army Corps of Engineers 2001). In the 1940s, dense riparian vegetation and sedimentation narrowed the Gila River channel and, by the 1980s, the stream had a compound appearance similar to its meandering channel geometry of the 1890s (Graf 1988 from US Army Corps of Engineers 2001). Due to the role of large storm events, the change from braided back to meandering channel morphology is much slower than the change from meandering to braided channel geometry.

Horizontal instability (resulting from changes in discharge, sediment load and riparian vegetation) is often present in dryland braided river systems. On large alluvial fans, the plugging of channels with sediment and debris results in dramatic changes in the location of active channels (Graf 1988, Mount 1995 from US Army Corps of Engineers 2001). Rates of channel migration are highly variable and depend on the magnitude of storm flows and the resistance of channel substrate. In addition to horizontal instability, many dryland channels exhibit substantial vertical instability through entrenchment. In continuous channels, channel entrenchment can result from the rapid upstream migration of headcuts during large storm events (Graf 1988 from US Army Corps of Engineers 2001). In general, channel entrenchment is the result of some change in the amount and/or rate of delivery of water and sediment to the river channel. Three common types of causal mechanisms for the above changes include land management, climatic change, and internal adjustments (Graf 1988, Mount 1995 from US Army Corps of Engineers 2001). Although there is substantial debate in the literature regarding the causal link between specific land use changes and the associated physical processes that lead to channel entrenchment, many arid river systems can exhibit substantial vertical channel change during large storm events (Graf 1988 from US Army Corps of Engineers 2001).

A healthy watershed operates in dynamic equilibrium. This balance can be affected by management activities, off-forest uses, and natural events such as droughts and wildland fires. Heavy precipitation and flood events cause erosion and sedimentation, and naturally occurring

chemical compounds found in the rocks can affect surface water quality. Management activities, public uses and natural events that disturb the soil surface, as well as those that impede or remove streamflow, generally have the greatest potential to affect aquatic and riparian-dependent resources. The risk of adverse impacts increases the closer a ground-disturbing activity is to a stream, riparian area or wetland. Surface water, floodplains, groundwater, wetlands, and riparian areas are all closely related through proximity to one another and through interflow of water traveling at the subsurface between streams and groundwater aquifers (Winter and others 1998).

Watershed Conditions

The US Forest Service Manual, chapter 2520 defines watershed condition as “The state of a watershed based upon physical and biological characteristics and processes affecting hydrologic and soil functions.” Watershed condition, or watershed health, on the Prescott NF vary depending on amount of disturbance that has occurred within each watershed and the effect of the disturbance on the natural integrity of the sub-watershed (HUC-12) as a whole.

The USDA Strategic Plan for FY 2010-2015 targets the restoration of watershed and forest health as a core management objective of the National Forests and Grasslands. A National Watershed Condition Team was formed to develop methodology for the Watershed Condition Framework (WCF) process.

Human caused disturbances that can adversely affect a watershed's condition include the location of National Forest System and non-system roads, mining, recreation, grazing, and timber harvest. The severity of effects is influenced in part by the local terrain, fire regime, precipitation and potential geological hazards. Changes in watershed condition are reflective of changes in the long-term reliability of a watershed to provide the expected water quality and quantity. Most conditions leading to poor ratings are associated with high road densities, agriculture, and mining within the national forest. Watershed conditions are described in the Forest Service Manual (FSM 2521.1) using three classes:

- Class 1 watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition (Functioning or Good).
- Class 2 watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition (At Risk or Fair).
- Class 3 watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition (Impaired or Poor).

These assessments are general in scale and do not consider site specific analyses required for proposed project specific activities. It is important to note that these condition classes do not prohibit future management activity. Site specific information pertaining to proposed management will be required before ascertaining if an activity will further degrade a watershed.

Table 6. Overall Watershed Condition Assessment

Condition Class	Sub-watersheds	Total Acres	FS Acres	Non-FS Acres
1 - Functioning	12	318,715	147,564	171,151
2 - At Risk	83	1,694,773	1,076,526	618,247
3 - Impaired	2	50,812	32,407	18,405

Of the 127 sub-watersheds on the Prescott NF, 97 were analyzed. Five of these sub-watersheds consist entirely of National Forest System lands, and a third are at least 90% administered by the Forest Service. All of the sub-watersheds that were analyzed were assigned a watershed condition rating (Table 6) based on the twelve key indicators identified in the WCF (Forest Service 2011a). Prior analysis for the Ecological Sustainability Report (Forest Service 2009b) was performed at the HUC-10 watershed level, however, new methodology was used for the WCF and the HUC-12 sub-watershed was determined to be the appropriate scale of analysis to influence and track changes in condition class over time.

Overall, eighty-three (85%) of the HUC-12 (sub-watersheds) administered at least in part by the Prescott NF were rated as “At Risk” condition. At the HUC-10 or watershed scale, all watersheds with the exception of Lower Big Chino Wash were rated as “At Risk”.

The twelve indicators are grouped into four watershed process categories: Aquatic Physical, Aquatic Biological, Terrestrial Physical, and Terrestrial Biological. The Aquatic Physical category contains three indicators; Water Quality, Water Quantity, and Aquatic Habitat. The Aquatic Biological and Terrestrial Physical categories each have two indicators; Aquatic Biota and Riparian/Wetland Vegetation for the Aquatic Biological category, Roads & Trails and Soils for Terrestrial Physical. The remaining five indicators are in the Terrestrial Biological category; Fire Regime or Wildfire, Forest Cover, Rangeland Vegetation, Terrestrial Invasive Species, and Forest Health. Each of the indicators are assessed and combined to produce a watershed score which falls into one of three classes. A full listing of the sub-watersheds and their condition indicator ratings are listed in Appendix A; a summary of the number of sub-watersheds in each condition class, by indicator, is shown below in Table 7.

Table 7. Sub-watershed conditions, by indicator

Condition	1. Water Quality	2. Water Quantity	3. Aquatic Habitat	4. Aquatic Biota	5. Riparian Veg.	6. Roads & Trails	7. Soils	8. Fire Regime	9. Forest Cover	10. Rangeland Veg.	11. Invasive Species	12. Forest Health
Functioning	68	61	29	33	28	0	6	3	39	2	97	97
At Risk	23	23	44	52	52	12	46	91	4	34	0	0
Impaired	6	13	24	12	17	85	45	3	54	61	0	0

Ratings for the condition indicator Water Quality showed approximately 30% (29 of 97) of the HUC-12 sub-watersheds were found to be “At Risk” or “Impaired” and are limited to 12 of the 22 HUC-10 watersheds. An “At Risk” rating indicates that there is minor impairment to beneficial

uses of the water bodies in the sub-watershed. “Impaired” sub-watersheds show significant impairment to beneficial uses of the water bodies in the watershed. Areas of greatest concern are the Agua Fria/Hassayampa Watersheds and Cherry Creek and Fossil Creek Watersheds in the Verde River.

The indicator Water Quantity rated 63% of the HUC-12 sub-watersheds as “Functioning”, 24% as “At Risk”, and 13% as “Impaired”. A “Functioning” rating for Water Quantity means that the sub-watershed exhibits a rate of flow consistent with natural conditions free from the influence of human-created features (e.g., dams and canals) or management actions. “At Risk” sub-watersheds may have moderate recognized departures from these conditions for part of the year, and in “Impaired” sub-watersheds the magnitude, duration, or timing of annual extreme flows (low or high) depart significantly from the natural rate of flow.

The indicator Aquatic Habitat rated 30% of the HUC-12 sub-watersheds as “Functioning”, 45% as “At Risk”, and 25% as “Impaired”. This indicator addresses aquatic habitat conditions with respect to habitat fragmentation, large woody debris, and channel shape and function. Sub-watersheds with functioning aquatic habitats support large continuous blocks of high-quality habitat and stream channel conditions. At risk sub-watersheds support medium to small blocks of contiguous habitat. Some high-quality aquatic habitat is available, but stream channel conditions show signs of being degraded. Impaired sub-watersheds support only small amounts of continuous high-quality aquatic habitat and most stream channel conditions show evidence of being degraded by disturbance.

The indicator Aquatic Biota rated 34% of the HUC-12 sub-watersheds as “Functioning”, 54% as “At Risk”, and 12% as “Impaired”. This indicator addresses the distribution, structure, and density of both native and introduced aquatic fauna. In the functioning sub-watersheds, all the native aquatic communities appropriate to the watershed are present and self-maintaining. At risk sub-watersheds are strongholds for one or more native aquatic communities within the native range, and the range may have been reduced within the watershed. Impaired sub-watersheds may support small, widely scattered populations of native aquatic species, but exotic or non-native invasive species are pervasive.

Ratings for the indicator Riparian/Wetland Vegetation showed approximately 30% of the HUC-12 sub-watersheds as “Functioning”, 54% as “At Risk”, and about 16% of the HUC-12 are “Impaired”. “Functioning” sub-watersheds contain native vegetation that is functioning properly throughout the stream corridor or along wetlands and water bodies. In those “At Risk”, disturbance partially compromises the properly functioning condition of native vegetation attributes in stream corridor areas or along wetlands and water bodies. In the “Impaired” sub-watersheds, a large percent of native vegetation attributes along stream corridors, wetlands, and water bodies is not functioning properly. At the Watershed (HUC-10) scale, most HUC-10 have both “Functioning” and “At Risk” sub-watersheds.

The Roads and Trails indicator showed that 12% of the HUC-12 sub-watersheds were rated as “At Risk”. In these sub-watersheds, there is a moderate chance that the stream channels and flows, sediment amounts, water quality, and riparian conditions have been substantially altered due to the density and distribution of the roads and trails. The remaining 88% were rated as “Impaired”, meaning that there is a higher probability that the hydrologic conditions have been substantially altered by the roads and trails.

On the condition indicator for Soils, 7% of the HUC-12 sub-watersheds were rated as “Functioning”, 47% were rated “At Risk”, and 46% were rated as “Impaired”. “Functioning” soils show minor or no alteration to reference soil condition, including erosion, productivity, and chemical characteristics. For those “At Risk”, a moderate amount of alteration to reference soil condition is evident and the overall soil disturbance is characterized as moderate. “Impaired” soils display significant alteration to reference soil condition and the overall soil disturbance is characterized as extensive.

The Fire Regime or Wildfire indicator addresses the potential for altered hydrologic and sediment patterns due to altered fire frequency and severity. Three percent of the sub-watersheds were rated as “Functioning”, 94% were rated “At Risk”, and 3% were rated as “Impaired” for this indicator. The “Functioning” sub-watersheds have a low likelihood of losing defining ecosystem components because of the presence or absence of fire. The likelihood rises to moderate for “At Risk” sub-watersheds, and to a high likelihood for those classified as “Impaired”.

The Forest Cover condition indicator rated 40% of the HUC-12 sub-watersheds as “Functioning”, 4% as “At Risk”, and 56% as “Impaired”. These ratings are based on the amount of land in the sub-watershed that is cut-over, denuded, or deforested. For functioning sub-watershed, this is less than five percent; for at risk sub-watersheds it is between five and fifteen percent. Impaired sub-watersheds are those where more than fifteen percent of the land is deforested. Extensive loss of forest cover affects runoff, erosion, sediment supply, bank stability, large woody debris retention, and stream temperature relationships.

Assessment of the indicator Rangeland Vegetation showed 63% of the HUC-12 sub-watersheds as “Impaired” and 35% as “At Risk”. This indicator addresses impacts to soil and water relative to the vegetative health of rangelands. In sub-watersheds that have been rated as impaired for Rangeland Vegetation, the composition of the vegetation has been greatly reduced or unacceptably altered compared to the natural potential of the area. In areas rated as at risk, the vegetation has a slight to moderate deviation from natural potential.

All ninety-seven sub-watersheds analyzed were rated “Functioning” for the condition indicator Invasive Species. This indicator addresses potential impacts to soil, vegetation, and water resources due to terrestrial invasive species (including vertebrates, invertebrates, and plants). In a functioning sub-watershed, there are few or no populations of terrestrial invasive species infesting the watershed that could necessitate removal treatments affecting soil or water resources.

All ninety-seven sub-watersheds analyzed were also rated “Functioning” for the condition indicator Forest Health. This indicator addresses forest mortality impacts to hydrologic and soil function due to major invasive and native forest pest, insect, and disease outbreaks and air pollution. In a functioning sub-watershed, only a small amount of the forested land is anticipated to experience, or is experiencing, tree mortality from insects, disease, or air pollution.

Riparian and Wetland Resources

Riparian ecosystems comprise the transition area between the aquatic ecosystem and the adjacent terrestrial system. The aquatic system includes the stream channel, lakebed, water, and the biotic community and habitat.

In the arid western United States, riparian areas are estimated to be less than 2% of the total land area and may be as low as 0.4% of Arizona's total area (Ffolliott et al., 2004 from Zaines, 2007). The role of riparian areas in arid and semiarid environments is disproportionate to their occurrence. Ephemeral and intermittent channels comprise 94% of stream miles within Arizona (Levick et al., 2007). Although there is much debate of whether areas adjacent to these dry streams are truly riparian, they serve many of the same ecological and hydrologic functions as riparian areas of perennial streams such as providing hydrologic connectivity, roughness to slow stream velocities, sediment transport, surface and subsurface water storage and exchange.

Wetlands are areas inundated by surface or groundwater with a frequency sufficient to support vegetation or aquatic life that requires saturated or seasonally saturated soil conditions. Wetlands include marshes, bogs, wet meadows, river overflows, mud flats, ponds, springs and seeps. Federal policy dictates that no net loss of wetlands on federal lands will occur.

Riparian and wetland systems on the Prescott NF in terms of occurrence, structure, function, and extent are dependent on a number of physical factors including geological setting, substrate, stream gradient, depth to groundwater, contributing watershed, and elevation. Elevation can have a significant effect on riparian vegetation as a function of the changes in temperature, precipitation, and timing, duration, and magnitude of streamflows. Listed below are generalized descriptions of the riverine riparian communities present across the Prescott NF:

Riverine riparian systems below 3,200 feet (desert)

For streams and riparian systems in this elevation zone, low precipitation and higher air temperatures result in high stream water temperatures and rates of evapo-transpiration. This riparian community is associated with perennial, intermittent and ephemeral streams that generally exhibit broad floodplains and terraced bottoms. Sparse vegetation can be found along the stream banks, with minimal vegetation in the stream channel. The vegetation consists of deep-rooted trees like saltcedar (*Tamarisk* L. spp. - Invasive), Arizona sycamore, Fremont cottonwood, and many herbaceous plants (*Carex* L. spp., *Juncus* L. spp., *Eleocharis* R. Br. spp., *Scirpus* L. spp., and *muhlenbergia* spp.). Large stands of willow, cottonwood, and mesquite dominated these areas before the European settlers (ASU 2007 from Forest Service 2008a).

Riverine riparian systems between 3,200-6,500 feet

Surrounding upland terrestrial vegetation can include chaparral, piñon-juniper, and oak woodlands. The prevalent riparian tree species in this zone primarily consist of Fremont cottonwood, willows, Arizona sycamore, velvet ash and Arizona walnut. In addition, the understory supports several species of herbaceous plants. This category supports the greatest number of plants and has the highest canopy cover as compared to the other elevation categories. The vegetation covers narrow strips along primarily intermittent and ephemeral streams because very few perennial streams remain in these elevations (ASU 2007 from Forest Service 2008a).

Riverine riparian systems greater than 6,500 feet

Characteristic woody species include willows, chokecherry (*Prunus virginiana* L.), boxelder (*Acer negundo* L.), Rocky Mountain maple (*Acer glabrum* Torr.) and various conifers along with

herbaceous plants. Increased perennial soil moisture can also support wetlands and mountain meadows. The terrestrial uplands support spruce-fir, mixed conifer and pine forests and in some cases aspen stands (ASU 2007 from Forest Service 2008a).

The location of springs and seeps are a result of both precipitation and geologic structure, generally being at the intersection of an impervious geologic strata and the land surface. Table 8 includes the relative density of springs and seeps in average number per square mile. Watershed areas having high precipitation and geologic strata with relatively low permeability (e.g. granitic /metamorphic with lower degrees of fracturing) may have higher incidence of small local springs. Lake Pleasant, Upper Hassayampa, and Big Bug 5th level watersheds in the upper portion of the Bradshaw Mountains are in this category (Forest Service 2008a). Cherry Creek, which drains the east side of Mingus Mountain, also has a high density. Watershed areas with more permeable substrates may contribute to ground water recharge which percolates deeper at the point of infiltration and surfaces at springs a further distance from the upland areas of precipitation. In these cases the location of the springs is often downstream from the National Forest, e.g., the Verde River headwater springs near the confluence with Granite Creek (Forest Service 2008a).

Table 8. Springs and seeps, by watershed (5th level HUC)

Watershed	PNF Area		Springs & Seeps			
	sq mi	% of WS	WS	PNF	PNF %	#/sq mi
Muddy Creek	18	9.8%	0	0	0.0%	0.00
Upper Burro Creek	13	7.7%	11	0	0.0%	0.00
Boulder Creek	16	10.8%	15	3	20.0%	0.18
Kirkland Creek	74	18.3%	71	25	35.2%	0.34
Sycamore Creek – S M	152	64.3%	61	52	85.2%	0.34
Lower Partridge Creek	1	0.4%	1	0	0.0%	0.00
Middle Big Chino Wash	38	12.7%	1	0	0.0%	0.00
Williamson Valley Wash	169	52.6%	52	46	88.5%	0.27
Lower Big Chino Wash	136	37.5%	18	17	94.4%	0.12
Granite Creek-Upper Verde	70	19.5%	36	21	58.3%	0.30
Hell Canyon	104	44.0%	6	2	33.3%	0.02
Sycamore Creek - Verde	35	7.4%	68	6	8.8%	0.17
Grindstone Wash	227	73.5%	14	2	14.3%	0.01
Cherry Creek	117	51.6%	84	60	71.4%	0.51
Fossil Creek	65	21.7%	69	25	36.2%	0.39
Ash Ck & Sycamore Ck	232	89.1%	84	82	97.6%	0.35
Big Bug Creek-Agua Fria	90	27.6%	52	39	75.0%	0.44
Black Canyon Creek	158	64.9%	70	54	77.1%	0.34

Watershed	PNF Area		Springs & Seeps			
	sq mi	% of WS	WS	PNF	PNF %	#/sq mi
Bishop Creek	26	11.0%	37	7	18.9%	0.27
Lake Pleasant	25	6.6%	129	18	14.0%	0.73
Upper Hassayampa	192	63.3%	141	102	72.3%	0.53
Middle Hassayampa	3	0.8%	34	2	5.9%	0.71
Totals	1,962	31.0%	1,054	563	53.4%	0.29

The Prescott NF has 563 springs and seeps inventoried in the National Hydrologic Dataset. At the sub-basin level (4th level HUC) the Forest administers about 13% of the land area but provides 32% of the known existing springs and seeps. The importance is most evident in the Big Chino Wash and Hassayampa River sub-basins where Prescott NF constitutes 16% and 13% of the land area, respectively, but provides 83 and 59% of the springs and seeps (Forest Service 2008a).

Water Quality

Water quality has been assessed in most of the major perennial and intermittent stream reaches and lakes on the Forest. Currently on the Prescott NF, the most important sources of water quality degradation are past and present mining activities, livestock grazing, roads, and ground disturbances created by off-highway vehicle use.

Water quality is assessed by comparing existing conditions (State Water Quality Category 1 – 5) with desired conditions set by the State, under authority of the Clean Water Act (CWA). Waters that are not impaired (those not on 303 (d) list or Category 4 or 5) are providing beneficial uses identified for that stream, and can be considered in a desired condition. The Arizona Department of Environmental Quality (ADEQ) is the regulating authority for water quality in Arizona. Standards are established for designated uses and individual water bodies are classified as to the designated uses for which water quality standards are applied. Primary designated uses include:

- Aquatic and Wildlife, cold water (generally applied to elevations above 5,000 feet)
- Aquatic and Wildlife, warm water (elevations below 5,000 feet)
- Full Body Contact – bacterial contamination (*E. coli*, etc.)
- Partial Body Contact – generally wading but not submersion, less stringent
- Municipal Water Supply
- Domestic Water Source
- Fish Consumption
- Agricultural Irrigation
- Agricultural Livestock Watering

The general classification used for surface water quality by ADEQ is Attaining, Impaired, Inconclusive, and Not attaining for the identified uses. The classification designates each waterbody in one of five categories.

Table 9. ADEQ Water Quality Attainment Categories

Category	Category Description								
1	Attaining All Uses There is sufficient data to determine that all designated uses are supported.								
2	Some Uses At least one designated use assessed as “attaining” and all other uses are assessed as “inconclusive” due to a lack of sufficient sampling data.								
3	Insufficient data All designated uses are “inconclusive” (by default, any surface water not assessed due to lack of credible data is actually included in this category).								
4	Impaired or threatened for at least one use but a TMDL not required. <table border="1"> <tr> <td>4A</td><td>A TMDL has already been completed</td></tr> <tr> <td>4B</td><td>Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard</td></tr> <tr> <td>4C</td><td>The impairment is caused by pollution but not a pollutant.</td></tr> <tr> <td>4N</td><td>The impairment is caused solely by natural conditions (an Arizona list only).</td></tr> </table>	4A	A TMDL has already been completed	4B	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard	4C	The impairment is caused by pollution but not a pollutant.	4N	The impairment is caused solely by natural conditions (an Arizona list only).
4A	A TMDL has already been completed								
4B	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard								
4C	The impairment is caused by pollution but not a pollutant.								
4N	The impairment is caused solely by natural conditions (an Arizona list only).								
5	Impaired or threatened for one or more designated uses by a pollutant, and a TMDL needs to be developed or revised.								

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. ADEQ is responsible for preparing TMDL analyses which include measures designed to reduce the pollutants causing impairment to levels where water quality standards can be met.

The ADEQ interprets its surface water quality standards to apply to “intermittent, non-navigable tributaries.” The DEQ interprets the definition of “surface water” to include tributaries (“the tributary rule”) and assigns water quality standards to intermittent surface waters that are not specifically listed by name in Arizona’s surface water quality standards rules. The DEQ feels it is necessary to regulate and protect these types of waters as “waters of the United States” because it is estimated that approximately 95% of the surface waters in Arizona are either intermittent or ephemeral.

Surface water quality standards do not apply to groundwater. The DEQ has independent statutory authority to develop aquifer water quality standards, and has adopted Aquifer Water Quality Standards. Groundwater standards in Arizona are the Safe Drinking Water standards established

for public water systems and surface water standards for the Domestic Water Source designated use.

There are 126 miles of Prescott NF stream courses (including perennial, intermittent, and ephemeral reaches) which are included in the most recent ADEQ assessment from 2008. Of these, 27% are rated as attaining all standards (Category 1). Categories 2 and 3, with some sampling data but not enough to determine attainment for all designated uses, make up 23%. Of these 29 miles only the 3.4 mile Copper Basin Wash and 0.5 miles of a tributary to Lynx Creek had an individual sample with an exceedance of sampled parameters. Two lakes, Granite Basin Lake and Lynx Lake, are listed in the assessment with additional monitoring required. The remaining 50%, or 63 miles is classified as impaired, most of it having an approved TMDL (Category 4) and some not yet completed (Category 5). Metal leaching from historic mining operations are the reason for the impaired rating of approximately 20 miles of Turkey Creek and 9 miles of the Hassayampa. Completion and implementation of TMDL's is expected to improve water quality. Remediation projects on the Hassayampa River and Lynx Creek have been initiated. The remediation on Turkey Creek has been completed. The majority of streams classified as "Not Attaining" are in the Verde sub-basin. These streamcourses include nearly all of the Verde River from the Perkinsville Bridge downstream to the boundary with the Tonto National Forest, in four separately listed reaches-- all due to turbidity. A TMDL for turbidity has been prepared with recommendations that when implemented, are predicted to improve the water quality to a status of attaining (Forest Service 2008a).

Table 10 (Forest Service 2008a) documents the water quality category ratings and sampling data for 5th level watersheds, stream segments or lakes. This water quality data is the most recent published by the State of Arizona.

Table 10. Water Quality Summary

Basin (HUC-6)	Watershed (HUC-10), Lake, or Stream Segment	Category	Comments
Bill Williams	Kirkland Creek	3	Copper Basin Wash, the only assessed stream in the Bill Williams Basin, is rated in Category 3, Inconclusive, due to limited sampling. The one sample analyzed suggested high levels of copper, lead, and selenium. Additional samples, taken over at least three seasons, are required.
	Lower Big Chino Wash	3	Inconclusive, due to inadequate samples. Only 1.8 of the 20.1 assessed miles are on the Forest. The samples taken did not find any exceedances.
Verde	Granite Creek-Upper Verde	3 or 4	Granite Creek above Willow Creek confluence is assessed as inconclusive by ADEQ and as impaired for dissolved oxygen by EPA. The report indicates that sampling points were within the Prescott urban area and several miles below the Prescott NF. Additional sampling is called for (ADEQ 2005).

Basin (HUC-6)	Watershed (HUC-10), Lake, or Stream Segment	Category	Comments
Verde	Granite Basin Lake	3	This 7 acre lake is assessed as attaining the standard for fish consumption but inconclusive with regard to other designated uses. ADEQ concluded that one low dissolved oxygen reading in late summer of a severe drought year was natural due to lake turnover. More testing is needed(ADEQ 2005).
	Verde River from Granite Creek downstream to HUC boundary at USGS Paulden gage.	1	Rated as attaining all uses (Category 1). Historically, this area was grazed by livestock. The removal of livestock coincides with improvements in water quality conditions (ADEQ 2001; ADEQ 2007).
	Sycamore Creek-Upper Verde River	1	This 7.6 miles is rated as slightly upward in trend due to reduced impact of livestock grazing. However, there are still some problems with unauthorized ATV use affecting the lower portion.
	The Verde River from vicinity of the Perkinsville Bridge to Railroad Draw	4A	The Verde River from vicinity of the Perkinsville Bridge to Railroad Draw is assessed as attaining all designated uses except for warm water aquatic life due to exceedances of turbidity and thus is classified as Category 4A. Continued turbidity levels are the result of natural background levels. A Turbidity TMDL was approved and implementation of recommendations is expected to improve water quality. ADEQ recommended that the turbidity standard be replaced with a suspended sediment standard. Subsequent sampling has found water quality to exceed this proposed standard only during flood flows, a natural occurrence in this ecosystem. Bio-assessment data indicated turbidity levels are not impairing macro-invertebrate communities. Because of this data and the protection of stream banks from livestock impact this reach is considered to be trending slightly toward reference condition (ADEQ 2005).
	The Verde River from Sycamore Creek to the HUC boundary	4A	The Verde River from Sycamore Creek to the HUC boundary is assessed the same as the previous reach, i.e., Category 4A due to turbidity. The same TMDL and trend applies (ADEQ 2005). This 6 mile reach is part of the boundary with the Coconino National Forest.

Basin (HUC-6)	Watershed (HUC-10), Lake, or Stream Segment	Category	Comments
Verde	Cherry Creek-Upper Verde River	4A	Only 3.2 miles of the 31 mile reach of the Verde River through the middle Verde Valley is adjacent to the Prescott NF. The remainder is private land passing through the communities of Clarkdale and Cottonwood and ending at Camp Verde. Numerous irrigation ditches dating to the 1800's reduce the flow of the Verde River and subsequent return flows affect water quality. This reach is a part of the turbidity TMDL previously discussed. Because of the impacts of rapid urbanization and greatly increased vehicular and recreational impacts the trend is estimated to be away from reference condition (ADEQ 2005).
	Fossil Creek-Lower Verde River	1	Gap Creek is assessed as Category 1, attaining all uses. The 5.4 mile reach from Government Springs to the Verde River had enough data to make this determination. The 2001 Prescott NF Watershed Condition Assessment for select Verde River 5 th code watersheds reported Gap Creek to have little or no resource impact and be in good/stable condition. Trend is rated as stable or toward reference condition (ADEQ 2005).
	Verde River from Camp Verde "White Bridge" to boundary between Prescott NF and the Tonto National Forest	4A	Verde River from Camp Verde "White Bridge" to boundary between Prescott NF and the Tonto National Forest includes two contiguous ADEQ reporting reaches. Both reaches were assessed as Category 4A with the same turbidity TMDL and trend as discussed in previous HUCs (ADEQ 2005). This 15.5 mile reach is the boundary with the Coconino National Forest.

Basin (HUC-6)	Watershed (HUC-10), Lake, or Stream Segment	Category	Comments
Agua Fria	Big Bug Creek-Agua Fria River	2	Lynx Lake is assessed as Category 2, attaining for cold water aquatic, fish consumption and agricultural uses. However, it is inconclusive for full body contact and domestic water source. Exceedances in manganese and lead in some of the samples suggest a need for more sampling to determine if a TMDL is needed (ADEQ 2005). This 50 acre lake is downstream from Lynx Creek. A number of historic mines are upstream and runoff and leachate from tailings, along with drainage from some mine adits, has affected water quality in the lake. The Forest has undertaken remediation projects on several of these sites, resulting in improved conditions and a trend toward reference condition.
	Lynx Creek tributaries in its headwaters	3	Lynx Creek tributaries in its headwaters include approximately 1.8 miles assessed as Category 3, inconclusive, of which about 0.5 mile is on the Forest. Runoff associated with historic mining activities has been measured with some samples showing exceedances of metals – zinc, copper, and cadmium; however, the number of samples and of exceedances was not enough to assess whether it is attaining the designated uses. Remediation was done at the Blue John site in 2005 in one of the two tributaries. Although not included in the 2006 ADEQ assessment, all of Lynx Creek is covered by water quality standards. The Sheldon Mine, on private land in the other tributary, is being evaluated by the EPA for potential remediation.

Basin (HUC-6)	Watershed (HUC-10), Lake, or Stream Segment	Category	Comments
Agua Fria	Black Canyon Creek	5	Turkey Creek, which drains a major portion of the east side of the Bradshaw Mountains, has been split into two reaches for assigning designated uses, based on the division between cold and warm water aquatic life at about 5,000 feet elevation. Portions of the lower segment have been assessed as impaired since 1992. A draft TMDL completed in September, 2006 recommended that this 21 mile reach, of which 19.7 miles is Prescott NF, be delisted for cadmium and zinc but found it still impaired (Category 5) for copper and lead. Tailings from the Golden Belt and Golden Turkey mines downstream from the FR 159 bridge were identified as the primary source of pollutants. The TMDL recommended a remediation program including removing tailings from the floodplain, capping and re-vegetating tailings, and control of pollutant escape from shafts and adits. This project was completed in July, 2007. The reach has both intermittent and ephemeral segments, but is not perennial. Because of this major remediation project the trend is considered to be upward (ADEQ 2005).
	The upper reach of Turkey Creek is 9.1 miles	4	The upper reach of Turkey Creek is 9.1 miles, of which 8.4 miles is National Forest. In 1998 it was combined with the lower reach into one overall Turkey Creek reach assessed as impaired. As a separate individual reach it is assessed as Category 2, attaining standards for aquatic life and livestock watering, but inconclusive for other designated uses due to an insufficient number of samples.
Agua Fria	French Lily Mine	4	The French Lily Mine was included in the remediation project with the Golden Belt and Golden Turkey mines. Its large tailings pile is within a tributary to Poland Creek, which joins with Turkey Creek to form Black Canyon Creek. Although not included in the 2006 ADEQ assessment, its remediation is important in reducing the movement of heavy metals downstream toward Lake Pleasant.

Basin (HUC-6)	Watershed (HUC-10), Lake, or Stream Segment	Category	Comments
Agua Fria	Upper Hassayampa River	4A, 5	A 31 mile reach of the Hassayampa River from its headwaters to Blind Indian Creek (10 miles downstream from the Prescott NF Boundary) was listed as impaired in 1998 due to high levels of metals in the stream from historic mining activities near Hassayampa Lake. A first phase TMDL was completed in 2002. With the division of designated uses between cold and warm water aquatic life at 5,000 feet elevation, this reach was divided into two reaches. The upper reach extends from the headwaters to Copper Creek and is assessed as impaired, but with a TMDL for copper, cadmium, and zinc, placing it in Category 4A (ADEQ 2005). The identified sources are mining tailings and shafts on both private and National Forest land within an approximate one mile radius of Hassayampa Lake. A first step in remediation was completed by the Forest Service and EPA by treating the McClellan Mine tailings on both National Forest and private land. The Senator Mine, another identified source of pollutants, is on private land and is being evaluated by the EPA. Impairment from pH has also been determined; however a TMDL for this attribute has not been completed, resulting in the reach being assessed as Category 5 for pH.
	Hassayampa River downstream from Copper Creek	1	The lower elevation reach of the Hassayampa River downstream from Copper Creek is assessed as Category 1, attaining all designated uses.
	Minnehaha Creek	3	Minnehaha Creek, a tributary of the Hassayampa River with confluence at Wagoner, has been assessed as Category 3, Inconclusive. The very limited sampling found no exceedances but was inadequate to reach conclusions on attainment (ADEQ 2005).

Groundwater

A high proportion of the water used in the area surrounding the Prescott NF is from groundwater. Agricultural and residential water uses exceed other water uses; however, agricultural use within the Chino sub-basins has decreased since the 1960s and 1970s (USGS, 2005). Ground water is hydrologically connected to surface water and where withdrawn at a rate greater than recharge can lead to reduction of river flows, lower lake levels, and reduction or elimination of groundwater discharge to wetlands and springs. It also can influence the sustainability of

drinking-water supplies and maintenance of critical ground water-dependent ecosystems. Some streams in southern Arizona which were historically perennial have become ephemeral due to ground pumping lowering the water table below the streambed (e.g., the Santa Cruz River in the Tucson area) (Forest Service 2008a). Diversion of streamflows can reduce in-stream flows and aquifer recharge. In natural stream systems with a steady baseflow, long term recharge is assumed to be in balance with spring and stream discharge from the aquifer.

Greater recharge occurs in areas of higher precipitation, along geological faults and fractures, and in alluvial channels and floodplains when flooded. Forest snowmelt in higher elevations allows for greater infiltration to recharge groundwater aquifers. Recharge may also occur through transmission losses in hyporheic or losing streams. Some of the actual recharge may occur on alluvium downstream from the Forest with water precipitated on the Forest. Maintenance of conditions conducive to recharge is important in order to maintain the overall source for the ground water which is eventually discharged to springs and streams.

Several groundwater sub-basins overlap the Prescott NF boundaries. Those of particular importance are the Big Chino, Little Chino and the Verde Valley sub-basins in the Verde watersheds, and the Upper and Lower Agua Fria sub-basins in the Agua Fria watershed. The 1980 Arizona Groundwater Management Act established four Active Management Areas (AMA) including the Prescott AMA in selected areas where groundwater overdraft has occurred (ADEQ, 2000). The Prescott AMA is a composite the Little Chino sub-basin and the Upper Agua Fria sub-basin. Within the Prescott AMA, groundwater is the primary source for municipal, domestic, industrial, irrigation, and livestock uses. The population of the basin is projected to increase by 58% between 1990 and 2025 (ADEQ, 2000).

Groundwater use on the forest is limited to special-use permittees and National Forest System campgrounds and administrative sites in which wells are used for domestic purposes. Other groundwater uses include domestic livestock and wildlife uses of springs. Water balance calculations indicate that about 1 to 2 percent of annual precipitation recharges the Little Chino and Big Chino aquifers, and 4% of annual precipitation recharges the Verde Valley aquifer. This amount may have been reduced since the predevelopment period before 1940 (USGS, 2005). These aquifers receive most of their recharge from higher altitudes, predominantly land administered by the National Forest Systems. Overdraft of the regional aquifers is occurring as groundwater outflows from all three sub-basins are greater than inflows (ADEQ 2009). Most groundwater use occurs outside the forest boundary although the proximity to National Forest lands affects groundwater within Prescott NF lands.

Water Use

Water use, primarily has groundwater pumping has dramatically increased in aquifers which underlie the Prescott NF. Current projections indicate that future demands will continue to rise (ADEQ 2009). Pumping groundwater at rates that exceed the recharge potential will result in decreased baseflow of streams and reduce spring discharge. The potential to deplete these aquifers exists and the consequences to aquatic and water resources and wildlife could be extensive. The consumption of these waters is governed by the State of Arizona.

Many of the springs occurring on the Prescott NF have been developed or modified to accommodate stock use (Forest Service 2008a). Many of these springs are in degraded conditions and would benefit through implementation of protection measures.

Soils

Potential Natural Vegetation Types (PNVT) aggregated from Terrestrial Ecosystem Survey (TES) Ecological Units, were used to categorize Prescott NF lands based on soils, climate, and potential vegetation (Forest Service 2000). The PNVTs are ecological units based on biophysical settings and depict the potential vegetation type that would dominate a site under natural disturbance regimes and biological processes (Vander Lee and others, 2006). Additional information on PNVTs can be found in the Ecological Sustainability Report (Forest Service 2009b). Soil resource characteristics were evaluated and analyzed by PNVT. The crosswalk between TES ecological units and PNVTs are in the planning record.

The Terrestrial Ecosystem Survey (TES) of the Prescott NF (Forest Service 2000) was used to form TES Ecological Units (along with soils). Map Units (ecological units) are identified by numbers ranging from 30 to 660. There are 147 TES units mapped for the Forest.

The TES was mapped at a scale of 1:24,000 across the landscape. Therefore, differences in soil and vegetation can occur within units over short distances. Generally, vegetation types smaller than about 10 to 40 acres were not mapped and are included in larger TES map units. Individual map units are based on representative data collected across the Forest and may or may not represent existing and potential conditions at a specific location as depicted in the TES. The overall accuracy of mapping and information provided by the TES is considered reliable at the ecological unit or landscape level. Map unit delineation may represent an area dominated by one to three eco-types (components). The map unit is named according to the taxonomic classification of the dominant ecosystem (Forest Service 2000).

Soil Type by PNVT

The Forest can be described by 14 PNVTs. Table 11 contains landforms, parent material and soil taxonomy for each PNVT (Forest Service 2000). The percentage of the dominant soil taxonomy is provided to indicate the degree of variability and diversity within a PNVT.

Common landforms on the Forest consist of mountains, hills, and plains with varying positions. Parent Material commonly found on the Forest includes granite, basalt, limestone, sandstone, and metamorphic comprised of schist and gneiss. Dominant soil taxonomy includes Haplustalfs and Argiustolls.

Table 11. Soil types for PNVT

PNVT	Parent Material	Landforms	Dominant Soil Taxa
Aspen Forest	Granite, Schist	Lowland Plains, Low Hills	Udic Haploborolls (100%)
Great Basin Grassland	Limestone, Mixed Alluvium	Lowland, Elevated, and Valley plains	Palesustalfs (33%) Vertic Haplustalfs (20%)

PNVT	Parent Material	Landforms	Dominant Soil Taxa
Cottonwood /Willow	Mixed Alluvium	Valley Plains	Aridic Ustifluvents (60%) Oxyaquic Ustifluvents (32%)
Desert Communities	Metamorphic Schist	Mountains & Hills	Ustic Torriorthents (100%)
Mixed-Conifer with Frequent Fire	Granite, Schist & Gneiss	Mountains & Hills	Typic Dystrochrepts (65%) Eutric Glossoboralfs (26%)
Interior Chaparral	Granite, Metamorphic	Mountains & Hills	Lithic Haplustalfs (75%)
Madrean Encinal Woodland	Granite, Mixed Alluvium	Mountains & Lowland/Valley Plains	Udic Haplustolls (65%)
Mixed Deciduous Broadleaf Riparian Forest	Mixed Alluvium	Valley Plains	Oxyaquic Ustifluvents (58%) Riverwash (36%)
Piñon Juniper - Evergreen Shrub	Granite, Basalt, Limestone, Sandstone, Alluvium	Mountains, Hills, Elevated Hills	Argiustolls & Haplustalfs (50%)
Piñon Juniper – Grassland	Basalt, Limestone	Elevated & Lowland Plains	Vertic intergrades (32%) Typic Haplustalfs (27%)
Piñon Juniper – Woodland	Basalt, Limestone	Hills, Mountains, Lowland Plains	Haplustalfs (65%) Rock outcrops (25%)
Ponderosa Pine - Evergreen Oak	Granite, Metamorphic Schist	Hills, Mountains, Elevated Plains	Haplustalfs (53%) Lithic Ustorthents (27%)
Ponderosa Pine - Forest	Basalt, Metamorphic Schist	Hills, Mountains, Plains	Mollisols (33%), Udic Haplustalfs (27%)
Semi-Desert Grassland	Limestone, Basalt, Metamorphic Schist, Mixed Alluvium	Hills, Mountains, Plains	Haplustalfs (70%)

Soil Condition by PNVT

Soil Condition is an evaluation of soil quality or the capacity of the soil to function within its ecological capability to sustain biological productivity, maintain environmental quality and promote plant and animal health (FSH 2509.18, 2). Soil condition and soil productivity are directly correlated in this analysis and are used as a method to assess existing soil productivity (FSH 2509.18, 2). Soil condition evaluates how a soil unit is functioning within its ecological capacity. Soil function is the natural process which occurs within the soil resulting from the combined interactions of soil chemical, physical, and biological properties (FSM 2550). The three primary functions assessed for soil condition evaluations are included below (Forest Service 2000).

- **Stability:** The ability of the soil to resist erosion.
- **Hydrology:** The ability of the soil to absorb, store, and transmit water, both vertically and horizontally.
- **Nutrient Cycling:** The ability of the soil to accept, hold and release nutrients.

Soil condition classes are Satisfactory, Impaired, and Unsatisfactory, as defined below. For a detailed description of the methodology used for soil condition classification, see the Ecological Sustainability Analysis of the Prescott National Forest (Forest Service 2008a).

- **Satisfactory:** Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of the soil to maintain resource values and sustain outputs is high.
- **Impaired:** Indicators signify a reduction in soil function. The ability of the soil to function properly and normally has been reduced and/or there exists an increased vulnerability to degradation. An impaired category indicates there is a need to investigate the ecosystem to determine the cause and degree of decline in soil functions. Changes in land management practices or other preventative measures may be appropriate.
- **Unsatisfactory:** Indicators signify that a loss of soil function has occurred. Degradation of vital soil functions result in the inability of the soil to maintain resource values, sustain outputs or recover from impacts. Unsatisfactory soils are candidates for improved management practices or restoration designed to recover soil functions.

As can be seen in Table 12, currently about 48% (674,236 acres) of the soils are in “Satisfactory” soil condition; about 35% (489,208 acres) are “Impaired”; and 17% (236,700 acres) are rated “Unsatisfactory”. Most areas that are currently in impaired and unsatisfactory soil condition would most likely have historically been in satisfactory soil condition.

Table 12. Soil Condition

PNVT	Soil Condition Categories							
	Satisfactory		Impaired		Unsatisfactory		Forest PNVT Total	
	% of PNVT	Acres	% of PNVT	Acres	% of PNVT	Acres	% of PNVT	Acres
Aspen Forest	100 %	82	-- *	--	--	--	<0.01 %	82
Great Basin Grassland	0.0 %	0	46 %	28,606	54 %	33,599	4.4 %	62,205
Cottonwood /Willow	42 %	2,127	58 %	2,934	0.4 %	29	0.4 %	5,090
Desert Communities	57 %	3,513	43 %	2,673	--	--	0.4 %	6,186
Mixed-Conifer with Frequent Fire	100 %	8,995	--	--	--	--	0.6 %	8,995
Interior Chaparral	91 %	297,042	8 %	27,215	1 %	3,441	23.2 %	327,698
Madrean Encinal Woodland	64 %	4,765	--	--	36 %	2,628	0.5 %	7,393

* zero to trace amount

PNVT	Soil Condition Categories							
	Satisfactory		Impaired		Unsatisfactory		Forest PNVT Total	
	% of PNVT	Acres	% of PNVT	Acres	% of PNVT	Acres	% of PNVT	Acres
Mixed Deciduous Broadleaf Riparian Forest	11 %	1,324	53 %	6,517	36 %	4,446	0.9 %	12,287
Piñon Juniper - Evergreen Shrub	40 %	195,436	46 %	225,865	15 %	72,731	35 %	494,032
Juniper – Grassland	13 %	19,189	25 %	36,666	62 %	91,966	10.5 %	147,821
Piñon Juniper – Woodland	25 %	18,120	45 %	32,600	30 %	21,989	5.2 %	72,709
Ponderosa Pine - Evergreen Oak	92 %	64,130	8 %	5,885	--	--	5.0 %	70,015
Ponderosa Pine – Gambel Oak	89 %	44,696	11 %	5,386	--	--	3.6 %	50,082
Semi-Desert Grassland	11 %	14,817	85 %	114,861	4 %	5,871	9.6 %	135,549
Total	48 %	674,236	35 %	489,208	16 %	223,657	100 %	1,400,144

As can be seen in Table 12, the greatest areas of satisfactory conditions are found in the Mixed-Conifer with Frequent Fire (100%), Ponderosa Pine-Evergreen Oak (92%), Interior Chaparral (91%), and Ponderosa Pine- Gambel Oak (89%). These PNVTs are both more resilient and have had different management histories than other PNVTs. Soil functions are being sustained in these PNVTs.

The greatest areas of unsatisfactory soil conditions are found in the Juniper-Grassland (91,966 acres), Piñon-Juniper-Evergreen Shrub (72,731 acres), and the Great Basin Grassland (33,599 acres). Both the Juniper-Grassland and the Great Basin Grassland PNVTs have a large portion that is in impaired condition (62% and 54%, respectively).

Semi-Desert Grassland (85%), Cottonwood/ Willow (58%), and Mixed Deciduous Broadleaf Riparian Forest (53%) have the largest percent of impaired soil condition, however, the Cottonwood/ Willow and Mixed Deciduous Broadleaf Riparian PNVTs combined only represent about 1.25% of the Prescott NF. The ability of the soil to function properly and normally has been reduced and there is an increased vulnerability to degradation. Conditions in soils in this category could improve given a change in land management practices or improved application of mitigation measures (FSH 2509.18).

Maintaining satisfactory soil condition is essential for long-term soil productivity. Unsatisfactory soil condition (17% of Forest) reduces the ability and potential of the soil to grow plants and sustain productive, diverse vegetation. Restoration activity and/or very long periods of time would be needed to return these soils to a productive state (FSH 2509.18).

It should be noted that the piñon-juniper vegetation types constitute half of the acreage on the Prescott NF. As can be seen Table 12, these vegetation types all have a relatively low percentage of satisfactory soils conditions, with the piñon-juniper-evergreen shrub component having the highest amount (40%) of the acreage in satisfactory condition. These vegetation types are often types very susceptible to vegetation conversion from a lack of fire and grazing activity.

Another PNVNT worth noting is the Mixed Deciduous Broadleaf Riparian Forest. This PNVNT has a very low (11%) component in satisfactory condition. These riparian types make up a small portion of the Prescott NF (0.9%) but are responsible for a disproportionate amount of the ecological biodiversity and productivity on the forest. These soils show a need for improvement.

Summary of Soils

Overall, soils on the Prescott NF are functioning within their historic range of productivity. Only 17% of the forest soils are rated as unsatisfactory and hence show a large loss of productivity. Soils in the following PNVNTs are of particular concern: Juniper-Grassland, Great Basin Grassland, Mandrean-Encinal Woodland, and Mixed Deciduous Broadleaf Riparian Forest. In terms of extent, the Piñon-Juniper-Evergreen Shrub PNVNT has the most acreage of soils in impaired or unsatisfactory condition (298,596 acres), followed by the Juniper Grassland (128,632 acres) and Semi-Desert Grassland (120,732 acres) PNVNTs.

Summary of Alternatives

Alternative A – 1987 Forest Plan Direction

Alternative A would continue management under the existing plan for the Prescott NF. The plan provides for timber production, fuel wood harvest, hazardous fuel reduction treatments, prescribed fire and management of unplanned ignitions to meet resource objectives. Project specific to watershed restoration including improvement of riparian areas; road and trail maintenance, reconstruction, and decommissioning; and restoration of springs and seeps would continue as under the existing plan.

Under Alternative A, thinning to alter or restore vegetation structure and composition occurs on about 550 acres per year in ponderosa pine and on 300 acres per year in piñon-juniper vegetation. Fire managers treat about 7,835 acres per year using prescribed fire across all vegetation types.

Planned ignitions are coordinated with the Arizona Department of Environmental Quality, as well as with adjacent agencies, to ensure that exceedences of State or Federal emissions standards do not result.

Alternative B – The Proposed Revised Plan

Alternative B represents approximately 1-2 years of collaborative work with citizens, agencies, and Prescott NF employees in an iterative manner to respond to suggested changes in proposed plan components. It places an emphasis on restoring vegetation, structure, composition, and desired characteristics of fire to five ecosystems that are moderately or highly-departed from

desired conditions. It also addresses citizen concerns related to smoke emissions and responds to the anticipated effects of climate change. Eight potential wilderness areas are recommended.

Alternative B would increase the number of projects designed to improve watershed condition from 8-12 to 20-50. Focus on riparian area improvements would continue and the number improvements to groundwater dependent ecosystems would increase from 12 sites to 20 to 55 sites. Projects to reduce watershed impacts from roads and trails would increase from existing management. Alternative B would increase the amount of thinning and prescribed fire occurring across the landscape. Planned ignitions would range from 10,600 to 25,300 acres per year on average. Thinning treatments would range from 1,750 to 6,500 acres per year on average.

Planned ignitions would be coordinated with the Arizona Department of Environmental Quality, as well as with adjacent agencies, to ensure that exceedences of State or Federal emissions standards do not result. Additionally, wildland urban interface (WUI) areas would be given high priority for fuel reduction treatments, using mechanical methods and/or domestic animals in lieu of planned ignitions.

Alternative C – Vegetation and Wildlife Habitat Emphasis

Alternative C includes many of the same components of Alternative B, however, it responds to public comments to increase emphasis on vegetation trends within both grassland and ponderosa pine types. This focus improves vegetation conditions within important wildlife habitats and places less emphasis on some vegetation communities and recreational components. In addition, Alternative C includes more management treatment for native fish and other aquatic species and pronghorn habitats; there is much less emphasis on recommendation of potential wilderness areas.

Alternative C would increase the number of projects designed to improve watershed condition from 8-12 to 20-50. Focus on riparian area improvements would continue and the number improvements to groundwater dependent ecosystems would increase from 12 sites to 20 to 55 sites. Projects to reduce watershed impacts from roads and trails would increase from existing management. Alternative C would emphasize a higher range of prescribed fire and a lower range of thinning activity compared to Alternatives A and B. Planned ignitions would range from 15,500 to 22,800 acres per year on average and would be focused in grassland and ponderosa pine vegetation. Thinning treatments would range from 1,750 to 4,000 acres per year on average.

Response to smoke emissions in Alternative C is the same as that described in Alternative B.

Alternative D – Dispersed Recreation Emphasis

Alternative D includes an emphasis on providing increased dispersed recreation opportunities. Vegetation treatments would be similar to those in Alternative B or slightly reduced. Emphasis on pronghorn and native fish would be identical to Alternative B. Within recreational opportunities, there would be reduced emphasis on developed recreation, such as campgrounds, and increased emphasis on dispersed recreation such as adding trails, improving trailheads and adding designated dispersed sites. This alternative also includes recommendation of the highest number of potential wilderness areas.

Alternative D would increase the number of projects designed to improve watershed condition from 8-12 to 20-50. Focus on riparian area improvements would continue and the number improvements to groundwater dependent ecosystems would increase from 12 sites to 20 to 55 sites. Projects to reduce watershed impacts from roads and trails would increase from existing management. Alternative D would emphasize less prescribed fire than Alternatives B and C, and similar or less thinning activity. Planned ignitions would range from 10,600 to 18,800 acres per year on average. Thinning treatments would range from 1,750 to 4,000 acres per year on average (the same as Alternative C).

Response to smoke emissions in Alternative D is the same as that described in Alternative B.

Methodology and Analysis Process

The analysis of the environmental consequences of the proposed actions was based on professional judgment and consultation with the Prescott NF plan revision team, the Prescott NF forest hydrologist, field reconnaissance, and literature review.

Assumptions

- The land management plan provides a programmatic framework for future site-specific actions.
- Land management plans do not have direct effects. They do not authorize or mandate any site-specific projects or activities (including ground-disturbing actions).
- Land management plans may have implications, or environmental consequences, of managing the forests under a programmatic framework.
- Law, policy, and regulations will be followed when planning or implementing site-specific projects and activities including the implementation of Best Management Practices as required by EPA and ADEQ.
- The plan decisions (desired conditions, objectives, standards, guidelines, management areas, monitoring) will be followed when planning or implementing site-specific projects and activities.
- Monitoring will occur and the land management plan will be amended, as needed.
- Management activities that help ecosystems accommodate changes adaptively will improve ecosystem resiliency in the long-term.
- The planning timeframe is 10 years; other timeframes may be analyzed to compare anticipated trends into the future.
- Activities associated with aquatic restoration will not impact water resources and the effects do not vary between alternatives.
- Action on opportunities acquire land to retain open space would serve to protect water resources.

Environmental Consequences

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity. Because the land management

plan does not authorize or mandate any ground-disturbing actions, there are no direct effects. However, there may be implications, or longer term environmental consequences, of management the Prescott NF under this programmatic framework.

Watersheds are naturally dynamic in responses to disturbances such as drought, floods, and wildland fire. These watersheds can also be affected by forest management activities. On a large scale, activities that disturb the soil surface as well as those that alter stream flow have the greatest potential to affect aquatic and riparian resources. Site specific activities such as mining also have high potential to impact water resources. The risk of adverse impacts increases as the distance between a ground disturbing activity and a stream or wetland decreases. Surface water, groundwater, floodplains, and riparian areas are all closely related. Because the effects on these resources are typically similar, they are discussed together unless specifically noted and described. Water yields from timber harvests and prescribed burns can be significant on a small scale such as in a sixth-level watershed, resulting in channel degradation if significant. On a larger scale, such as from the forest as a whole, these yields are a very small fraction of the forest's overall water yield and are not measurably detectable from year-to-year.

Watershed conservation practices and forest plan standards and guidelines prescribe extensive measures to protect soil, riparian, and aquatic resources. Adverse impacts to these resources can be minimized or eliminated when Best Management Practices are implemented. Situations may exist where impacts may be unavoidable. In these situations, the extent and the duration of the disturbance from the management activities as well the long term benefits must be considered in assessing the impacts to water resources.

Vegetation Management

Common to all Alternatives

The risks to watershed condition from vegetation manipulation including timber harvest and prescribed fire most commonly include erosion, compaction, sedimentation, timing of peak flows and increased water yield in sub-watersheds (i.e. sixth-level watersheds). Riparian ecosystems can be affected by vegetation manipulation as well. The degree of impact depends on site specific features such as soil erosivity, steepness of slopes, susceptibility to mass wasting, as well as the spatial extent and intensity of the prescribed activity. Low-intensity fires typically leave sufficient organic matter to protect the soil surface. In contrast, high-intensity fires can consume duff, litter, and critical amounts of the vegetation and sterilize soils. Roads, landings, skid trails, and fire lines associated with management activity can increase the risk of erosion and sedimentation.

Vegetation manipulation can measurably increase streamflow within the immediate watershed for limited periods of duration. Vegetation evapo-transpiration is generally the first factor to recover. Research has shown that it takes extensive vegetation manipulation to realize any increases in water yield, and that the predominant time of year in which water yield can be increased is during flood events (Schmidt and Wellman 1999 from Forest Service 2008b). Healthy riparian stands act as sponges, and meter out water yield for late season flows. Higher flow rates create greater capacity to erode and transport sediment within the stream system. Significant increases in peak flows and their duration can adversely impact channel stability and aquatic habitat. Riparian vegetation also serves to create roughness that reduces stream velocity and stabilize stream banks.

Removal of riparian vegetation can lead to bank erosion during high streamflows (Neary and others, 2010).

If fuels are not managed on the Prescott NF, high intensity fires from unplanned ignition has a greater potential to occur and impact water resources and it is useful to compare the impacts typically related to wildfire with those from prescribed fire efforts.

Soils may respond to high-intensity fires by becoming hydrophobic (water repellant) thereby reducing the potential for infiltration and increasing overland flow. The loss of riparian vegetation removes buffers to streams. With little vegetation or organic matter to slow down overland runoff and intercept sediments, receiving stream systems can experience increased peak flows and sedimentation. Burned over watersheds that provide a source for municipal water supplies are of most concern. Downstream flooding from severely burned watersheds is also a concern where dwellings and other structures located in a floodplain are at risk.

Comparison of Alternatives

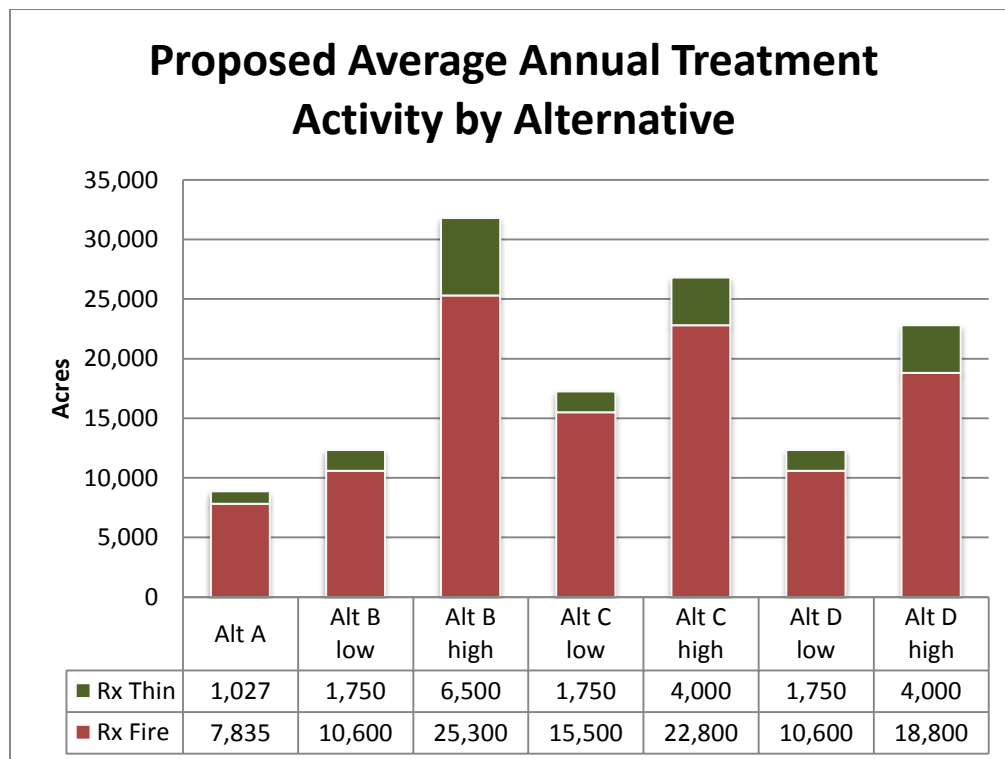


Figure 1. Proposed acres of vegetation treatments, by alternative

Alternative A continues the current management as directed in the 1987 Plan. Current trends would restore the fewest acres using managed fire and mechanical vegetation treatments (Figure 1). The result would be the slowest rate of improvement in watershed function among the alternatives, and no plan emphasis for watershed restoration. The rate of progress in addressing vegetation structure under Alternative A is slower than the rate at which these impacts to the

watershed have been accumulating. It can be reasonably assumed that in the absence of a change in management direction these impacts will continue to accumulate into the future.

The goals in the 1987 Plan for providing for increased water flow via large scale chaparral removal (e.g., Battle Flat project) are outdated, but would remain in place under Alternative A. Projects such as the Battle Flat treatment represent an inefficient approach towards improving watershed integrity that is not sufficient to reverse the decline in watershed function on the forest.

The current levels of prescribed burning and mechanical vegetation treatment have been insufficient to affect a recovery in watershed function across the forest. Most of the sub-watersheds on the forest are currently in an at-risk condition and the continuation of management direction under Alternative A would not provide the guidance necessary for measurable improvement.

Areas displaying current poor conditions for soil and forest cover such as Grindstone Wash and Hell Canyon watersheds in the Upper Verde sub-basin would be unlikely to recover function. Watersheds such as Williamson Valley Wash in the Big Chino Wash sub-basin with a substantial number of sub-watersheds in at-risk or impaired condition would be likely to trend downward into further impairment.

All action alternatives (B, C, and D) propose to treat more acreage in PNVTs that have poor soil conditions, including Semi-Desert Grasslands, Great Basin Grasslands, Juniper Grasslands, and Piñon-Juniper-Evergreen Shrub. Figure 1 compares annual acres proposed for prescribed burning and thinning by alternative. As these vegetative communities recover with annual treatments, soils would move towards a satisfactory condition. As organic matter and ground cover increase, the three primary soil functions of stability, hydrology, and nutrient cycling would recover in these treated areas.

Alternative B proposes the most acres burned under managed fires. The acreages presented represent both a risk to watershed resources as well as a protection measure from higher-intensity wildfires. Although all fire reduces vegetation, thereby increasing the potential for erosion, the overall impacts to watershed resources of a prescribed fire typically are less than those of a wildfire. Short term effects including increased peak flows and sedimentation are possible from the proposed treatments, however the benefits from these treatments are expected reduce erosion and enhance soil productivity over time. The short and long term effects to water resources would be greater if large high intensity wildland fire were to occur.

The higher range of Piñon-Juniper acres treated in Alternative B could benefit Grindstone Wash and Hell Canyon watersheds in particular. Both of these watersheds contain a high percentage of Piñon-Juniper types (89% and 98%, respectively) as well as an impaired rating for Soil in all of their sub-watersheds. They also each contain a high percentage of acres rated as impaired for Forest Cover and Rangeland Vegetation.

Alternative C proposes more fire treatments in Semi-Desert and Great Basin Grasslands and less overall treatments in the Piñon-Juniper vegetation types than the proposed alternative (B). This would favor more soil recovery in the PNVTs with increased treatments and less recovery in the others.

Alternative D has less overall treatment in the Piñon-Juniper types than the proposed alternative (B). This will have the effect of less improvement in soil conditions to the Piñon-Juniper types.

Roads and Trails

Common to all Alternatives

Roads and to a lesser extent, trails are associated with many forest uses including timber harvests, recreation, mining, and are probably the most significant source of increased sediments into stream channels on the forest. Roads and trails create lineal features with impermeable surfaces that have low roughness. Many roads are located in proximity to surface waters and concentrate runoff, thereby increasing the ability to transport sediment and reducing the time for runoff to reach the stream. Roads, especially when not designed using Best Management Practices, increase the drainage density. Roads constructed on steep slopes or high erosion hazard areas result in more displaced material.

Once sediment enters a drainage network it will be transported through the system as stream volumes and velocities allow. Deposition of sediments occurs where or when flow rates are not sufficient for their transport in suspension. These impacts cannot be estimated at the programmatic level such as a forest plan. They will, however, be included in project-level analyses. The existing transportation system on the Prescott NF is a source of sediment and increased peak flows from runoff. Roads and trails are also features which provide opportunities for many human uses. Desired conditions, standards and guidelines, and goals related to roads for the plan revision were generated as part of the planning process. These criteria were created with the objective to protect water resources. The alternatives generated define these criteria as components of Watershed Integrity. Refer to the Watershed Integrity section in Environmental Consequences for a comparison of alternatives and mitigative activities related to roads.

Mining

Common to all Alternatives

Mining activity can cause significant long-term impacts to surface and groundwater quality. Metal ores on the Prescott NF have leached pollutants such as zinc, copper, lead, selenium, and cadmium. Deep in the ground, these minerals are normally stable. Mining exposes these ores to air or water. Metals that come in contact with acidic runoff dissolve easily and enter a water body in solution. Aquatic life and riparian vegetation are poisoned by acidic water and released toxins. Without protective vegetation along stream banks, channel erosion also will occur. Some mining activity, such as exploration, simply disturbs the soil, leaving surfaces exposed to erosive forces. Past problems with mining are discussed in the affected environment section and also the supporting ecological sustainability analyses. Historic and recreational mining on the Prescott NF is prevalent in many areas of the forest and surrounding private lands. Future mining activities may occur, but will be required to mitigate impacts to water resources. Commercial mining activity does not vary by alternative.

Watershed Integrity

Common to all Alternatives

All of these activities are designed to improve water resource conditions. Impacts to water resources from roads and trails are described under the roads section.

Comparison of Alternatives

Alternatives B, C, and D have the greatest potential to improve watershed resources. The least potential for improvement to water resources is through Alternative A. Table 13 summarizes the differences between alternatives. There are no measurable differences between alternatives B, C, and D and goals for watershed integrity. The primary differences between Alternatives A versus B, C, and D are increases in watershed restoration projects, increases in road improvements that impact water resources, and increases in spring protection.

Table 13. Comparison of Alternatives: Watershed Integrity

	Current Plan	Alternative B	Alternative C	Alternative D
Projects to Improve Watershed Conditions.	4,180 acres, 3 miles, and 2 other projects Estimate 8 to 12 projects	20 – 50 projects	20 – 50 projects	20 – 50 projects
Improve conditions in identified improperly functioning and at risk riparian areas within 1-5 years of detection.	Timing of treatments unknown 10 acres and 17 segments improved	10-40 %	10-40%	10-40 %
Maintain or repair designated motorized roads or trails that impact watershed integrity.	30 miles, 2 erosion control projects, and 62 acres improved	20 to 100 miles	20 to 100 miles	20 to 100 miles
Obliterate, close, re-contour, or revegetate unauthorized routes that impact watershed integrity.	23 miles and 14 acres obliterated	Minimum of 10 miles	Minimum of 10 miles	Minimum of 10 miles
Improve stream or drainage crossings by roads or trails.	2 crossings improved	15 to 25 crossings	15 to 25 crossings	15 to 25 crossings

	Current Plan	Alternative B	Alternative C	Alternative D
Enhance and restore ground water dependent ecosystem sites (seeps and springs).	12 sites	25 to 55 sites	25 to 55 sites	25 to 55 sites

Recreation

Common to all Alternatives

Water plays an important part in many aspects of recreation. Lakes and streams are attractions to those recreating on the forest. Water provides basic needs in campgrounds and other recreation sites. The availability of water enhances most recreational uses, and conversely, recreational pursuits have varying degrees of impact on this resource. Many developed and dispersed recreation sites are located in or near surface water, and developed sites frequently have plumbed facilities. Trails and roads, especially those that are user created, frequently lead to and parallel streams. Recreational mining commonly occurs in or near streams. Likewise, most wilderness visitors travel to and camp near lakes or streams. Such concentrated use typically results in trampling of riparian zones and stream banks, damage to riparian vegetation, and soil compaction. Erosion and sedimentation can occur. The risk of water pollution from human waste, dishwashing, trash accumulation, and horse use is higher where people congregate. These risks can be reduced by carefully designing recreation sites and trails to avoid riparian areas. Stream crossings should be minimized and routes for motorized and non-motorized off-highway vehicles should terminate a distance from water bodies to avoid adverse impacts to riparian zones and water quality. Interpretive tools such as signs and the presence of forest staff on site can help to educate forest users about ways to reduce their impacts to water resources.

Alternative D proposes more dispersed recreation and less developed recreation sites. As stated above, these sites are commonly near water resources. With increased dispersed recreation, there is the potential for increased trampling, soil compaction, and a decrease in soil productivity. The Mixed Deciduous Broadleaf Riparian Forest PNVT was identified above as having a low overall satisfactory rating. Increases in dispersed recreation in these areas has the potential to decrease soil recovery.

Comparison of Alternatives

Alternatives B, C, and D have the greatest potential to improve watershed resources. The least potential for improvement to water resources is through Alternative A. The alternatives B, C, and D would not likely have a measurable difference in environmental consequences to water resources between them. The primary differences between Alternatives A versus B, C, and D are improvements in signing, public education, implementation of protection measures in impacted areas, and increased trail improvements and maintenance. All of these activities are likely to result in improvements to water resources. The addition of developed recreation areas and designation of dispersed areas have the potential to impact soil and water resources. The design features and maintenance specific to these facilities would influence the potential effects. Factors

such as the size, proximity to surface water, stability of the site, season of use, are relevant to determining the effects. Assumptions made are that protection measures would be part of the design criteria, and that implementation of these recreation areas would not result in degradation to water resources.

Table 14. Comparison of Alternatives: Recreation

	Current Plan	Alternative B	Alternative C	Alternative D
Additional Developed Recreation Areas	0	2 to 5	2 to 5	1 to 2
Additional Designations of dispersed camping areas.	0	1 to 4 areas	1 to 4 areas	2 to 6 areas
Percent reduction in maintenance backlog—Developed Rec. sites.	88%	80 to 90%	80 to 90%	50 to 60%
Percent reduction in maintenance backlog—trails.	No reduction, expected; increase	50 to 70%	35 to 50%	50 to 70%
Designated target shooting areas.	1 area exists; permit will not be renewed	1 area	1 area	1 area
Improvement in trailheads.	None reported	5-20 trailheads	5-10 trailheads	10-25 trailheads
Annual trail sign Maintenance.	3 to 5%	10 to 20%	10 to 20%	10 to 20%
Enhance fishing opportunities.	2 lake treatments	2 lakes or ponds	2 lakes or ponds	2 lakes or ponds
Enhance means of communication with visitors.	No	Develop 2-5 additional communication methods	Develop 2 to 5 additional communication methods	Develop 2 to 5 additional communication methods
Improved identification of designated wilderness boundaries.	1 mile marked	2 to 5 areas	2 to 5 areas	2 to 5 areas
Add protective measures where there is evidence of resource damage due to Recreation sites or use.	2 locations	2 to 5 locations	2 to 5 locations	2 to 5 locations

	Current Plan	Alternative B	Alternative C	Alternative D
Trail improvement to meet desired conditions (DC-Rec-2 Trails).	0	5 to 10 actions	5 to 10 actions	5 to 15 actions including 10 to 20 miles new trail construction and up to 5 miles trail decommissioning
Number of areas and total acreage of potential wilderness recommended.	0	8 areas 43,330 acres	0	16 areas 116,260 acres

Grazing

Common to all Alternatives

Grazing, as discussed here, refers to domestic livestock on National Forest System lands under a grazing permit. Historic grazing levels have been documented to be a source of impact to water resources (Wildeman and Brock 2000). Site specific issues concerns to water resources including riparian areas and springs currently exist. The impacts can include erosion, sedimentation, soil compaction, loss of wildlife and fish habitat, decreased water quality, and lowered water tables. When the impacts of livestock grazing range are substantial, modifications in the timing and/or amount of grazing activities reduce the overall impact in critical areas.

Currently active allotments do not vary across alternatives. The number of vacant allotments that are retained for potential restocking does not vary by alternative. Any actual reissuance of permits to restock any of the retained vacant allotments will be evaluated through site-specific NEPA analyses. Because vacant allotments that are retained have not been used for many years and will not be restocked without further analysis, there is no change in the risk from grazing to watershed resources in the forest plan decision.

Comparison of Alternatives

Alternative A continues the current management as directed in the 1987 Plan. Current trends would restore the fewest acres of grassland vegetation types (Semi-Desert Grasslands and Great Basin Grasslands), resulting in the slowest rate of improvement in the Rangeland Vegetation condition indicator. The rate of progress in addressing rangeland conditions under Alternative A is slower than the rate at which impacts to the watersheds have been accumulating. It can be reasonably assumed that in the absence of a change in management direction these impacts will continue to accumulate into the future.

Alternatives B and D provide guidance to at least double the number of acres of the grassland vegetation types on which wildland fire is used for treatment. This would have the most benefit in the Cherry Creek watershed, which contains over 95,000 acres, approximately one-third of

which are Semi-Desert Grasslands. All seven sub-watersheds within Cherry Creek have been rated impaired for Rangeland Vegetation and the increase in treatment acres could be expected to trend the Rangeland Vegetation indicator towards better conditions. Black Canyon Potential Wilderness Area is located within this watershed and would be recommended for designation under Alternative B, but not Alternative D. Vegetation treatments would be allowed at the discretion of the Forest Supervisor and should be consistent with the preservation of the wilderness character of the area.

Alternative C proposes almost three times as many acres of fire treatments in the grassland vegetation types as Alternatives B and D. The grassland vegetation types show a large percentage (92 percent) in impaired or unsatisfactory condition as determined by the ERS analysis (Forest Service 2009a). This would provide the most benefit to the Ash Creek / Sycamore Creek watershed in the Agua Fria sub-basin, Cherry Creek watershed in the Upper Verde sub-basin, and Lower Big Chino watershed in the Big Chino Wash sub-basin due to their high percentage of acres (19 to 34 percent) in grassland and generally poor soil conditions as rated by the WCF indicator. Condition indicators for Rangeland Vegetation could be reasonably expected to trend upward in these watersheds as a result of the increased treatments. As noted above, all seven sub-watersheds within the Cherry Creek watershed have been rated impaired for Rangeland Vegetation, and Alternative C would be the most likely alternative to improve rangeland vegetation conditions in this watershed due to the increased extent of treatments in the grassland.

Climate Change

Proposed treatments for each Alternative were evaluated for probable effects to water resources assuming these hotter, drier environmental conditions:

- Temperatures are expected to increase 0.5 degrees F per decade
- There will be more hot days with summer heat waves lasting 2 weeks or longer
- Precipitation may decrease
- Winters will be warmer with reduced snow pack and monsoon rains may start later.
- Extreme events, such as floods, may become more common.

Common to All Alternatives:

Qualitatively, climate change may result in:

- Reduced snowpack in higher elevations.
- Less water available for groundwater recharge.
- Reduced base flows.
- Increased area where precipitation does not exceed evapo-transpiration.
- Changes to stream channel morphology.

Hotter, drier environments are likely to enhance the size and severity of wildfires, and fire disturbance would increase. Larger, more frequent, high intensity fires would likely result in increased soil erosion, increased runoff, faster response to the hydrograph with higher peak flows, increased sedimentation, increased turbidity, and pulses of increased pH from ash. Severe fires

can often cause changes in succession rates, alter above- and belowground species composition, generate volatilization of nutrients and ash entrainment in smoke columns, produce rapid or decreased mineralization rates, alter C : N ratios, and result in subsequent nutrient losses through accelerated erosion, leaching or denitrification. In addition, changes in soil hydrologic functioning, degradation of soil physical properties, decreases in micro- and macro-fauna, and alterations in microbial populations and associated processes can occur (Neary, 1999). Soil formation and vegetation recovery is relatively slow in arid environments. The extent of loss to soil productivity would correlate to hydrologic effects. Changes to channels would likely include less vigorous riparian vegetation, reduced streambank stability, channel braiding and or downcutting, greater turbidity, and increased stream temperatures. Baseflows could be reduced in both volume and temporally.

Management approaches that enhance ecosystem resiliency and ability to adapt during climate change include:

- Reducing anthropogenic stresses.
- Reducing uncharacteristic disturbances.
- Allowing disturbances that promote adaptation and biodiversity.

Modifying vegetation structure and composition to more open conditions allows individual plants to better compete for limited water and nutrients, and facilitates ecosystem transition from current to new conditions, such as those that result from changing natural and human disturbance regimes (Millar and others 2007).

Landscape-scale application of wildland fire not only mitigates fire risk, it allows fire to continue to enhance resistance to loss, and to facilitate natural (evolutionary) adaptation, and migration as climate changes (Fulé 2008, Hurteau and Brooks 2011).

In the long-term, vegetation and fire treatment activities would be beneficial in building ecosystem resiliency and capacity for plant communities to accommodate expected changes imposed by future climate trends.

Comparison of Alternatives

Under the direction of the 1987 Plan in Alternative A, resilience to climate change would not likely be emphasized. Watersheds would continue to show some improvement in function, but the improvements would be at greater risk of reversing due to the potential effects of climate change. Alternative A provides the least amount of resilience and capacity for plant communities to adapt to changing climate and a less aggressive strategy for treating non-native invasive plants.

All three of the action alternatives have the same minimum number of acres treated in juniper grasslands and piñon-juniper evergreen shrub vegetation types, but Alternative B provides direction for a higher maximum. Thus, Alternative B has a greater potential to improve watershed function and strengthen resilience at a quicker rate than Alternatives A and D, but not as quickly as Alternative C. Alternative B also contains a more aggressive approach to controlling non-native invasive plants than Alternative A.

Alternative C would implement the quickest rate of improvement of watershed function and strengthening resilience, due to its emphasis on vegetation management and ecosystem

restoration. Alternative C contains the same direction for controlling non-native invasive plants as Alternatives B and D.

Alternative D would provide the slowest rate of improvement to watershed function of the three action alternatives, but would strengthen resilience more than Alternative A, due to more acres of vegetation treatment and more mitigation of recreation impacts. Alternative D contains the same direction for controlling non-native invasive plants as Alternatives B and C.

Cumulative Environmental Consequences

The cumulative effects analysis for this plan revision is being assessed at the 4th level HUC or sub-basin scale. It is impractical to complete a quantitative cumulative watershed effects analysis at this scale of strategic planning. Detailed quantitative cumulative watershed effects analyses will be completed at the project level. Table 15 displays the 4th level HUC intersecting the Prescott NF. The size of the sub-basins and the area administered by the Prescott NF are displayed and relevant to the potential cumulative effects Prescott NF activities may contribute to the sub-basins. The percentage of lands managed within the sub-basins by the Prescott NF ranges from 1% – 22%. Where multiple land ownership exists, it is important that the Prescott NF work with the appropriate organizations and individuals.

Table 15. Prescott NF 4th level HUC

Sub-basin	HUC-8	Sub-basin sq. miles	PNF sq. miles	PNF as % of Sub-basin
Agua Fria	15070102	2,785	531	19.10%
Big Chino Wash	15060201	2,153	344	16.00%
Big Sandy River	15030201	2,154	18	0.90%
Burro Creek	15030202	713	29	4.10%
Hassayampa	15070103	1,454	195	13.40%
Lower Verde	15060203	1,965	65	3.30%
Santa Maria River	15030203	1,433	227	15.80%
Upper Verde	15060202	2,507	553	22.10%
Totals		15,165	1,962	13.0 %

At the 4th level HUC scale, the conditions outside of the Prescott NF for groundwater dependent features (riparian and wetlands, seeps and springs, perennial streams, and water yield potential) and water quality were examined for the Ecological Sustainability Report (Forest Service 2009b). Species and their associated aquatic and riparian habitats (streams, rivers, etc.) were also examined with no regard for administrative boundaries. A determination was then made as to

whether there was a risk to the sustainability of each feature from actions and conditions in areas surrounding the Prescott NF.

At the sub-basin scale, the Big Chino Wash exhibits the most risk to sustainability. The features found to be at risk include the upland soils, the riparian and wetland areas, seeps and springs, perennial streams, and species associated with aquatic and riparian habitats.

Three sub-basins, Burro Creek, Hassayampa River, and Santa Maria River, were found to have four of seven features at risk for sustainability. All displayed risks to the sustainability of their riparian and wetland areas and species associated with aquatic and riparian habitats. The Hassayampa River sub-basin also showed a risk to water quality, the Santa Maria River sub-basin contained a risk to upland soils, and they both were at risk for their perennial streams. Burro Creek was at risk for its upland soils and seeps and springs.

The Upper Verde, Lower Verde, and Agua Fria sub-basins were determined to be at risk to sustainability for water quality and species associated with aquatic and riparian habitats. Additionally, the Upper Verde is at risk to sustainability for upland soils. There was not enough data to perform a risk assessment on the Big Sandy River sub-basin; the Prescott NF contributes only one percent to the sub-basin area.

Nearly all of the management activities conducted by the Prescott NF have potential to affect water resources. Their cumulative impact to a watershed depends upon the effects of past, present, reasonably foreseeable actions, and the watershed's sensitivity to disturbance.

Cumulative effects include activities on the Prescott NF as well as other public and private lands. Urbanization near and adjacent to the forest can contribute substantially to cumulative watershed effects. Development has the potential to affect aquatic and riparian resources through increased runoff and pollutants from roads, other impermeable surfaces, emissions, and fertilized lots. In addition to the above potential impacts, activities that have a high risk of adverse watershed impacts include water diversions and extractions, irrigation, loss of groundcover, mining, increased trail density and use, and trampling of riparian areas. The cumulative effects of management activities and the expansion of urban populations in vicinity of the Prescott NF trend toward increased pressure to develop more groundwater resources. The results are increased risks of damage to groundwater quality, lowered groundwater tables, reduced base flows, loss of groundwater dependent springs and seeps, and shifts in riparian species. In addition, there is increased risk to degrading surface and groundwater quality.

Unavoidable Adverse Impacts

The land management plan provides a programmatic framework that guides site specific actions but does not authorize, fund, or carry out any project or activity. Before any ground-disturbing actions take place, they must be authorized in a subsequent environmental analysis. Therefore none of the alternatives cause unavoidable adverse impacts. Mechanisms are in place to monitor and use adaptive management principles in order to help alleviate unanticipated impacts that need to be addressed singularly or cumulatively.

Irreversible and Irretrievable Commitment of Resources

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity. Because the land management plan does not authorize or mandate any ground-disturbing actions, none of the alternatives cause an irreversible or irretrievable commitment of resources.

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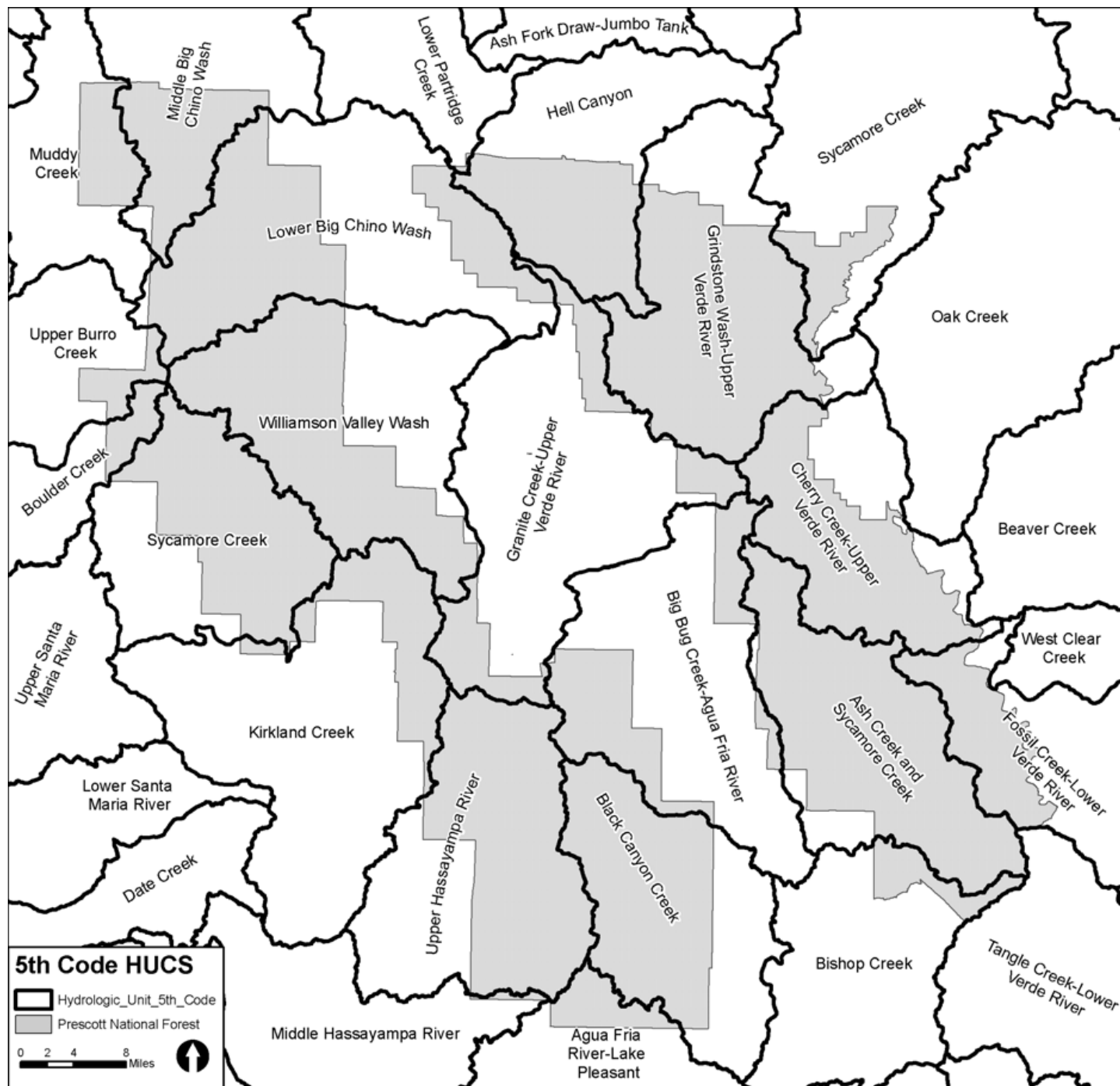
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Appendix A - 5th level HUC Watershed Map

Figure 2. 5th level HUC Watersheds on the Prescott NF



Appendix B – Watershed Condition Framework Assessment^{*}

Table 16. HUC-12 conditions

Code	Sub-watershed 6th code	Condition Class	1. Water Quality	2. Water Quantity	3. Aquatic Habitat	4. Aquatic Biota	5. Riparian Vegetation	6. Roads & Trails	7. Soils	8. Fire Regime	9. Forest Cover	10. Rangeland Vegetation	11. Invasive Species	12. Forest Health
150302010203	Buck Tank	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Poor	Fair	Good	Good
150302020202	Pine Creek	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Good	Fair	Good	Good
150302020301	Upper Boulder Creek	2	Good	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Good	Fair	Good	Good
150302030101	Tonto Wash	2	Good	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150302030102	Woolsey Wash	1	Good	Good	Fair	Good	Good	Poor	Good	Fair	Poor	Poor	Good	Good
150302030103	Upper Skull Valley Wash	2	Fair	Good	Poor	Fair	Good	Poor	Fair	Fair	Good	Fair	Good	Good
150302030108	Lower Skull Valley Wash	2	Fair	Good	Poor	Good	Poor	Poor	Fair	Fair	Good	Fair	Good	Good
150302030112	Cottonwood Canyon-Kirkland Creek	1	Good	Good	Fair	Good	Good	Poor	Poor	Fair	Poor	Fair	Good	Good
150302030201	Weed Canyon	2	Good	Fair	Poor	Fair	Poor	Poor	Fair	Fair	Poor	Poor	Good	Good
150302030202	Smith Canyon	1	Good	Good	Good	Good	Good	Poor	Poor	Fair	Poor	Poor	Good	Good
150302030203	Tank Creek	2	Good	Fair	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Good	Good
150302030204	Upper Sycamore Creek	2	Good	Good	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Poor	Good	Good
150302030205	Cottonwood Canyon	2	Good	Good	Poor	Good	Poor	Poor	Poor	Fair	Good	Poor	Good	Good
150302030206	Loco Creek	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good
150602010604	Road Canyon	2	Good	Good	Fair	Fair	Good	Poor	Fair	Fair	Poor	Fair	Good	Good
150602010605	Upper Turkey Canyon	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Good	Poor	Good	Good
150602010606	Lower Turkey Canyon	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Fair	Good	Good
150602010608	Maverick Tank-Big Chino Wash	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Fair	Good	Good
150602010701	Humphrey Wash	2	Good	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Good	Poor	Good	Good
150602010702	Pine Creek	2	Good	Fair	Fair	Good	Poor	Poor	Poor	Fair	Good	Fair	Good	Good
150602010703	Horse Wash	2	Good	Fair	Good	Fair	Good	Poor	Poor	Fair	Poor	Poor	Good	Good

^{*} Information in both tables is from the Watershed Condition Classification dataset: <http://www.fs.fed.us/publications/watershed/interactivemap/USDAFS-WCF-2010.html>

150602010704	Strickland Wash	2	Good	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602010705	Long Canyon	2	Good	Good	Poor	Fair	Fair	Poor	Poor	Fair	Poor	Fair	Good	Good
150602010706	Hitt Wash	2	Good	Good	Fair	Fair	Fair	Poor	Poor	Fair	Good	Fair	Good	Good
150602010707	Mint Wash	2	Good	Fair	Fair	Fair	Good	Fair	Fair	Fair	Good	Fair	Good	Good
150602010708	Upper Williamson Valley Wash	2	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602010709	Mud Tank Wash	2	Good	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602010801	Big Dam Tank	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Fair	Good	Good
150602010802	Limestone Tank-Big Chino Wash	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Fair	Good	Good
150602010803	Pine Creek	1	Good	Good	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Good	Good
150602010804	South Butte-Big Chino Wash	1	Good	Good	Good	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Good
150602010805	Upper Walnut Creek	2	Good	Fair	Fair	Good	Good	Poor	Poor	Fair	Good	Poor	Good	Good
150602010806	Lower Walnut Creek	2	Good	Poor	Fair	Good	Good	Poor	Poor	Fair	Good	Fair	Good	Good
150602010807	Red Hat Tank-Big Chino Wash	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good
150602010809	Telephone Tank-Big Chino Wash	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good
150602020101	Willow Creek-Willow Creek Reservoir	2	Good	Poor	Fair	Good	Fair	Poor	Good	Fair	Good	Fair	Good	Good
150602020102	Upper Granite Creek-Watson Lake	1	Fair	Fair	Good	Good	Good	Poor	Good	Poor	Fair	Poor	Good	Good
150602020103	Upper Lonesome Valley	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Good	Poor	Good	Good
150602020104	Lower Lonesome Valley	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Good	Poor	Good	Good
150602020108	Muldoon Canyon-Verde River	2	Good	Good	Poor	Poor	Poor	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020201	Manzanita Tank	2	Good	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020205	Limestone Canyon	2	Good	Good	Poor	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020206	Rattlesnake Wash	2	Good	Good	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Fair	Good	Good
150602020207	Wagon Tire Wash	2	Good	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020210	Grindstone Wash	2	Fair	Good	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Fair	Good	Good
150602020211	Lower Hell Canyon	2	Good	Good	Fair	Poor	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020313	Cedar Creek	2	Good	Good	Fair	Fair	Fair	Poor	Fair	Fair	Good	Poor	Good	Good
150602020314	Lower Sycamore Creek	2	Good	Good	Fair	Poor	Fair	Poor	Poor	Good	Poor	Poor	Good	Good
150602020401	Bull Basin Canyon-Verde River	2	Good	Good	Fair	Poor	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good

150602020402	Government Canyon	2	Good	Good	Poor	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020403	Munds Draw	2	Good	Good	Poor	Fair	Fair	Fair	Poor	Fair	Good	Fair	Good	Good
150602020404	Wildcat Draw-Verde River	2	Good	Good	Fair	Poor	Fair	Poor	Poor	Fair	Poor	Fair	Good	Good
150602020405	Railroad Draw	2	Good	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020406	Horseshoe Canyon-Verde River	2	Fair	Fair	Fair	Poor	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020701	Bitter Creek	2	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good
150602020702	Mescal Gulch-Verde River	2	Poor	Poor	Good	Poor	Good	Poor	Poor	Fair	Good	Poor	Good	Good
150602020703	Black Canyon	2	Good	Good	Poor	Fair	Fair	Poor	Poor	Fair	Good	Poor	Good	Good
150602020704	Oak Wash-Verde River	3	Poor	Poor	Poor	Poor	Fair	Poor	Fair	Fair	Good	Poor	Good	Good
150602020705	Cherry Creek	2	Fair	Poor	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Good	Good
150602020706	Hayfield Draw-Verde River	3	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Fair	Poor	Poor	Good	Good
150602020707	Grief Hill Wash-Verde River	2	Fair	Poor	Poor	Poor	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good
150602030301	Copper Canyon-Verde River	2	Fair	Poor	Fair	Poor	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good
150602030303	Chasm Creek-Verde River	2	Fair	Poor	Good	Poor	Good	Poor	Fair	Fair	Poor	Poor	Good	Good
150701020101	Cienega Creek	2	Good	Fair	Good	Fair	Good	Poor	Fair	Fair	Poor	Poor	Good	Good
150701020102	Upper Ash Creek	2	Fair	Fair	Good	Good	Fair	Poor	Fair	Fair	Good	Fair	Good	Good
150701020103	Osbourne Spring Wash	2	Good	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150701020104	Dry Creek	2	Good	Good	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150701020105	Little Ash Creek	1	Good	Good	Good	Fair	Good	Poor	Poor	Fair	Poor	Fair	Good	Good
150701020106	Lower Ash Creek	2	Good	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150701020201	Coyote Wash	1	Good	Good	Good	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Good
150701020202	Yaeger Canyon	2	Good	Good	Good	Fair	Good	Poor	Fair	Poor	Good	Poor	Good	Good
150701020203	Grapevine Gulch	2	Good	Good	Good	Fair	Fair	Poor	Good	Good	Good	Poor	Good	Good
150701020205	Lynx Creek	2	Fair	Poor	Fair	Fair	Good	Poor	Fair	Fair	Good	Poor	Good	Good
150701020206	Chaparral Gulch-Agua Fria River	2	Fair	Good	Fair	Fair	Fair	Poor	Fair	Fair	Good	Poor	Good	Good
150701020207	Yarber Wash	2	Good	Poor	Fair	Fair	Fair	Fair	Poor	Fair	Poor	Poor	Good	Good
150701020301	Bear Creek	2	Fair	Good	Poor	Fair	Poor	Poor	Fair	Fair	Good	Poor	Good	Good
150701020302	Wolf Creek	2	Fair	Good	Good	Fair	Fair	Poor	Good	Fair	Good	Poor	Good	Good
150701020303	Upper Turkey Creek	2	Poor	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Fair	Good	Good
150701020304	Cedar Creek	2	Fair	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor	Poor	Good	Good

150701020305	Poland Creek	2	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Fair	Poor	Good	Good
150701020306	Lower Turkey Creek	2	Poor	Good	Good	Good	Fair	Poor	Poor	Fair	Poor	Poor	Good	Good
150701020308	Black Canyon Creek (Local Drainage)	1	Fair	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Poor	Good	Good
150701020401	Little Sycamore Creek	2	Good	Good	Good	Fair	Good	Poor	Poor	Fair	Poor	Fair	Good	Good
150701020402	Sycamore Creek	2	Good	Good	Good	Fair	Fair	Poor	Fair	Fair	Good	Fair	Good	Good
150701020403	Big Bug Creek	2	Fair	Poor	Fair	Fair	Fair	Poor	Poor	Fair	Good	Fair	Good	Good
150701020404	Indian Creek	1	Good	Fair	Good	Good	Good	Poor	Poor	Fair	Poor	Fair	Good	Good
150701020503	Boulder Creek	1	Good	Good	Good	Good	Good	Poor	Good	Fair	Good	Poor	Good	Good
150701020506	Humbug Creek	2	Fair	Good	Poor	Good	Poor	Poor	Fair	Fair	Fair	Poor	Good	Good
150701030101	Groom Creek-Hassayampa River	2	Poor	Poor	Good	Good	Good	Poor	Fair	Poor	Good	Good	Good	Good
150701030102	Buzzard Roost Wash- Hassayampa River	2	Good	Good	Poor	Good	Poor	Poor	Poor	Fair	Good	Fair	Good	Good
150701030103	Crooks Canyon	2	Fair	Fair	Good	Fair	Good	Poor	Fair	Fair	Fair	Good	Good	Good
150701030105	Milk Creek	2	Fair	Fair	Fair	Good	Fair	Poor	Fair	Fair	Good	Fair	Good	Good
150701030106	Blind Indian Creek	1	Good	Good	Good	Good	Good	Fair	Poor	Fair	Good	Poor	Good	Good
150701030107	Minnehaha Creek	2	Fair	Good	Poor	Good	Poor	Fair	Fair	Fair	Good	Poor	Good	Good
150701030111	Cherry Creek	2	Good	Good	Poor	Fair	Poor	Fair	Poor	Fair	Poor	Poor	Good	Good
150701030112	Moore's Spring- Hassayampa River	2	Good	Good	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Fair	Good	Good
150701030301	Oak Creek	2	Good	Good	Poor	Good	Poor	Fair	Fair	Fair	Poor	Fair	Good	Good

Table 17. Select condition indicators aggregated at the HUC-10 scale

Watershed 5th code	Total Acres	5. Riparian Vegetation			6. Roads & Trails			7. Soils			8. Fire Regime			9. Forest Cover			10. Rangeland Vegetation			12. Forest Health
		Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good
Upper Hassayampa River	122,866	60,099	21,919	40,849		47,683	75,184		64,194	58,672		103,608	19,258	99,518	11,368	11,981	30,626	44,557	47,683	122,866
Grindstone Wash	116,943		116,943			18,454	98,490			116,943		116,943		18,454		98,490		38,612	78,332	116,943
Ash Creek / Sycamore Creek	113,544	57,779	55,765				113,544		55,619	57,925		113,544		26,568		86,975		55,296	58,247	113,544
Williamson Valley Wash	107,535	30,102	53,363	24,070		12,738	94,797		12,738	94,797		107,535		54,468		53,067		54,095	53,440	107,535
Black Canyon Creek	101,144	42,609	46,991	11,544		15,535	85,608	12,547	77,728	10,869		101,144		55,451	26,783	18,909		15,826	85,318	101,144
Sycamore Creek (Santa Maria Sub-basin)	97,360	25,791	9,501	62,067		4,920	92,440		21,878	75,482		97,360		32,491		64,869			97,360	97,360
Cherry Creek	96,615	29,998	49,558	17,059			96,615		49,130	47,485		96,615		60,460		36,155			96,615	96,615
Lower Big Chino	86,942	55,983	30,960			17,171	69,772		48,130	38,812		86,942		51,527		35,416		41,235	45,708	86,942
Hell Canyon	77,618		50,412	27,206			77,618			77,618		77,618				77,618		27,206	50,412	77,618
Bishop Creek	60,434	19,533	40,901				60,434		24,922	35,512		60,434		40,901		19,533		60,434		60,434
Kirkland Creek	45,671	15,820	18,391	11,459			45,671	2,112	22,894	20,664		45,671		22,894		22,776		25,167	20,504	45,671
Granite Creek	43,423	11,657	18,785	12,981			43,423	17,798	12,644	12,981		31,766	11,657	18,785	11,657	12,981		6,141	37,282	43,423
Big Bug Creek	40,575	22,476	18,099			5,340	35,235	5,171	30,785	4,619	5,171	29,186	6,218	35,235		5,340		721	39,854	40,575
Fossil Creek	39,937	24,192	15,745				39,937		39,937			39,937				39,937			39,937	39,937

Watershed 5th code	Total Acres	5. Riparian Vegetation			6. Roads & Trails			7. Soils			8. Fire Regime			9. Forest Cover			10. Rangeland Vegetation			12. Forest Health
		Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good
Sycamore Creek (Upper Verde Sub-basin)	35,668		35,668				35,668		6,635	29,033	29,033	6,635		6,635		29,033			35,668	35,668
Middle Big Chino Wash	23,890	4,754	19,136				23,890		23,890			23,890		12,145		11,745		11,745	12,145	23,890
Agua Fria River-Lake Pleasant	15,389	4,526		10,863			15,389	4,526	10,863			15,389		4,526	10,863				15,389	15,389
Muddy Creek	10,539		10,539				10,539		10,539		10,539					10,539		10,539		10,539
Boulder Creek	10,124		10,124				10,124		10,124			10,124		10,124				10,124		10,124
Upper Burro Creek	8,470		8,470				8,470		8,470			8,470		8,470				8,470		8,470
Middle Hassayampa River	1,811			1,811		1,811			1,811			1,811				1,811		1,811		1,811
Total Area		405,318	631,270	219,909		123,651	1,132,846	42,154	532,932	681,411	44,744	1,174,621	37,133	558,651	60,672	637,174	30,626	411,979	813,892	1,256,497
Percent		32%	50%	18%		10%	90%	3%	42%	54%	4%	93%	3%	44%	5%	51%	2%	33%	65%	100%